The AMSAT Journal

Incorporating the AMSAT Newsletter
Volume 13 No. 5 November 1990

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Satellites in the Classroom

By Kermit R. Allen
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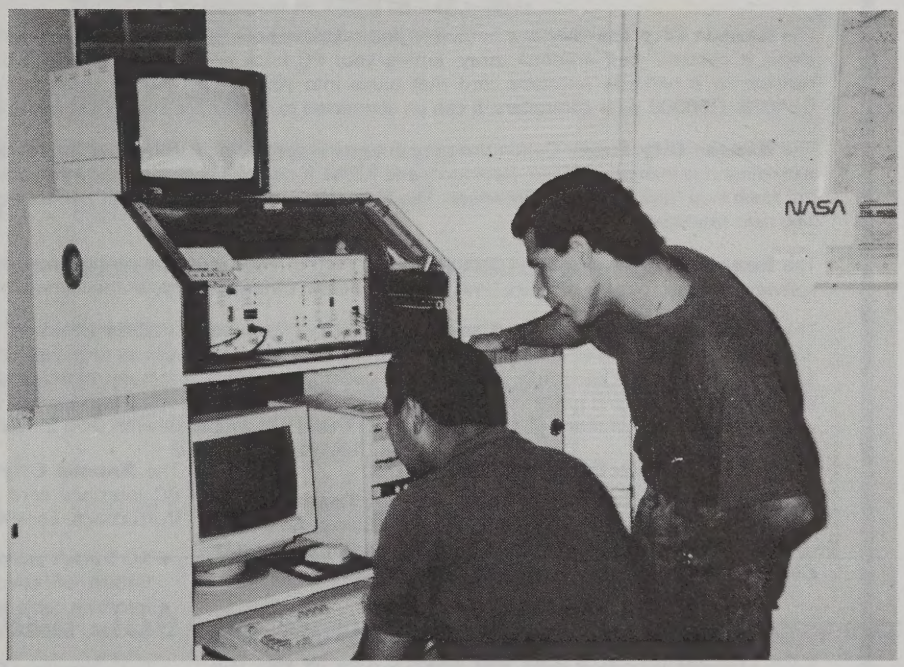
It was October 1989 at the ITT Technical Institute, West Covina, CA. The Center Director Mrs. Patricia Case challenged a Communications Electronics Instructor (myself) to reactivate the school's Weather Satellite Receiving Station. The equipment, manufactured by FeedBack Instruments Ltd., consists of a parabolic dish and a turnstile antenna mounted on the roof for receiving geosynchronous and polar satellite signals respectively. Each antenna was equipped with a preamplifier and the cables were connected to a common point where the geosynchronous satellite frequency was downconverted to the same frequency used for polar satellites. The common line then ran through the roof and into a classroom where the FeedBack WSR513 performed the conversions from FM to AM to an image on a video monitor.

As my previous experience with satellite reception was rather limited, the more I read about the reactivation, alignment and operation of a weather satellite receiver system, the more I realized this would be no small assignment even though the FeedBack equipment operator's manuals were available. Written on the inside of the manuals were references to Longitude, Latitude and an organization called NOAA. A firm working relationship with Ms. Mona Smith (NOAA) was established after a few phone calls and then the work began in earnest.

Mr. Simon Page of FeedBack Inc. was contacted. He provided invaluable advice on troubleshooting and optimizing our system. Assistance from NASA was received in the form of bi-weekly satellite prediction bulletins. Membership in the amateur satellite organization AMSAT was obtained and they provided additional tracking and organizational information sources. Most informative, however, were the FeedBack operators manuals, NOAA's Technical Report *NESDIS 44* and NASA's two line format booklet. Using these as a starting point, I began to acquire literature from every available source.

At first almost nothing seemed to work as it was supposed to. This was due to equipment problems and my lack of experience. On site assistance was provided by a local veteran satellite tracker, Mr. Ed Murashie, and included reorientation of the parabolic antenna as well as a system analysis of noise problems. One of the modules was found to be defective and adding noise to the system, thus degrading the video signal. Mr. Page was instrumental in its rapid repair and return. Many other anomalies were discovered during

(Continued on page 4)



"Student teaching student" using MS-DOS and tracking program.

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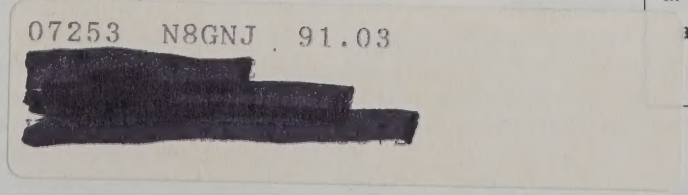
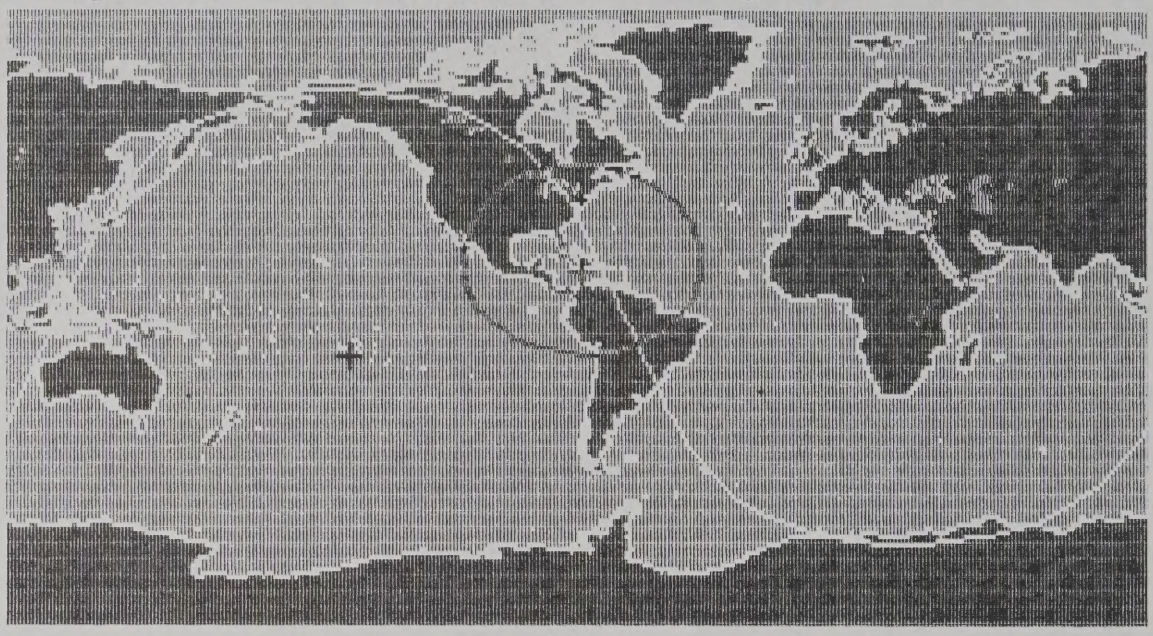


Satellite Tracking

with your PC and the Kansas City Tracker & Tuner



The **Kansas City Tracker** is a hardware and software package that connects between your rotor controller and an IBM XT, AT, or clone. It controls your antenna array, letting your PC track any satellite or orbital body. The **Kansas City Tracker** hardware consists of a half-size interface card that plugs into your PC. It can be connected directly to Kenpro 5400A/5600A or Yaesu G5400B/G5600B rotor controllers. It can be connected to other rotor assemblies using our Rotor Interface Option.

The **Kansas City Tuner** Option provides automatic doppler-shift compensation for digital satellite work. The **Tuner** is compatible with most rigs including Yaesu, Kenwood, and ICOM. It controls your radio thru the radio's serial computer port (if present) or through the radio's up/down mic-click interface. The **Kansas City Tuner** Option is perfect for low-orbit digital satellites like the NOAA and Microsat satellites.

The **Kansas City Tracker** and **Tuner** include custom serial interfaces and do not use your computer's valuable COMM ports. The software runs in your PC's "spare time," letting you run other programs at the same time.

The **Kansas City Tracker** and **Tuner** programs are "Terminate-and-Stay-Resident" programs that attach themselves to DOS and disappear. You can run other DOS programs while your antenna tracks its target and your radios are tuned under computer control. This unique feature is especially useful for digital satellite work; a communications program like PROCOMM can be run while the PC aims your antennas and tunes your radios in its spare time. Status pop-up windows allow the user to review and change current and upcoming radio and antenna parameters. The KC Tracker is compatible with DOS 2.00 or higher.

Satellite and EME Work

The **Kansas City Tracker** and **Kansas City Tuner** are fully compatible with N4HY's QUIKTRAK and with Silicon Solution's GRAFTRAK. These programs can be used to load the **Kansas City Tracker's** tables with more than 50 satellite passes.

DX, Contests, and Nets

Working DX or contests and need three hands? Use the **Kansas City Tracker** pop-up to work your antenna rotor for you. The **Kansas City Tracker** is compatible with all DX logging programs. A special callsign aiming program is included for working nets.

Packet BBS

The **Kansas City Tracker** comes complete with special control programs that allow the packet BBS user or control-op to perform automated antenna aiming over an hour, a day, or a week. Your BBS or packet station can be programmed to automatically solicit mail from remote packet sites.

Vision-Impaired Hams

The **Kansas City Tracker** has a special morse-code sender section that will announce the rotor position and status automatically or on request. The speed and spacing of the code are adjustable.

The **Kansas City Tracker** and **Tuner** packages include the PC interface card, interface connector, software diskette, and instructions. Each Kansas City unit carries a one year warranty.

- KC Tracker package for the Yaesu/Kenpro 5400A/5600A controller $189
- Interface cable for Yaesu/Kenpro 5400A/5600A ..... $ 19
- Rotor Interface Option (to connect to ANY rotors) ..... $ 30
- KC Tuner Option ..... $ 79
- N4HY QuikTrak software ..... $ 80

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The AMSAT Journal (ISSN: 1047-3076) is published bi-monthly (Jan., Mar., May, July, Sept., Nov.) for $15, inseparable from membership dues of $30 by AMSAT-NA, 850 Sligo Ave., Silver Spring, MD 20910, tel. (301) 589-6062. Second Class postage paid at Silver Spring, MD and additional mailing offices. Postmaster: send address changes to *The AMSAT Journal,* 850 Sligo Ave., Silver Spring, MD 20910.

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Dear Joe ... *This space is reserved for reader's comments.*

Educators Please Note

Dear Joe:

In the BYTIC club near Moscow we have a few classes equipped with IBM-PCs where schoolboys of all ages are studying Information Science. Approximately 1500 pupils take courses in computers during the school year. The club also participates in several exchange programs with foreign cities, mainly with Oakland, CA.

Our city also has many Amateur Radio stations. A few of them have agreed to establish a packet satellite communications group for educational purposes. We expect that the Microsats launched earlier this year can be used to establish a computer link via packet radio with other Amateur Radio club stations in different schools around the world. Thus a PACSAT can serve as a tool to aid in the development of direct contact between schools.

Astronomy, geophysics, geography, electronics, computers, language arts classes can all make use of the PACSATs. This club wants to establish contact with teachers and schools in different countries to organize a world-wide electronic mail system through the PACSATs for educational pur-

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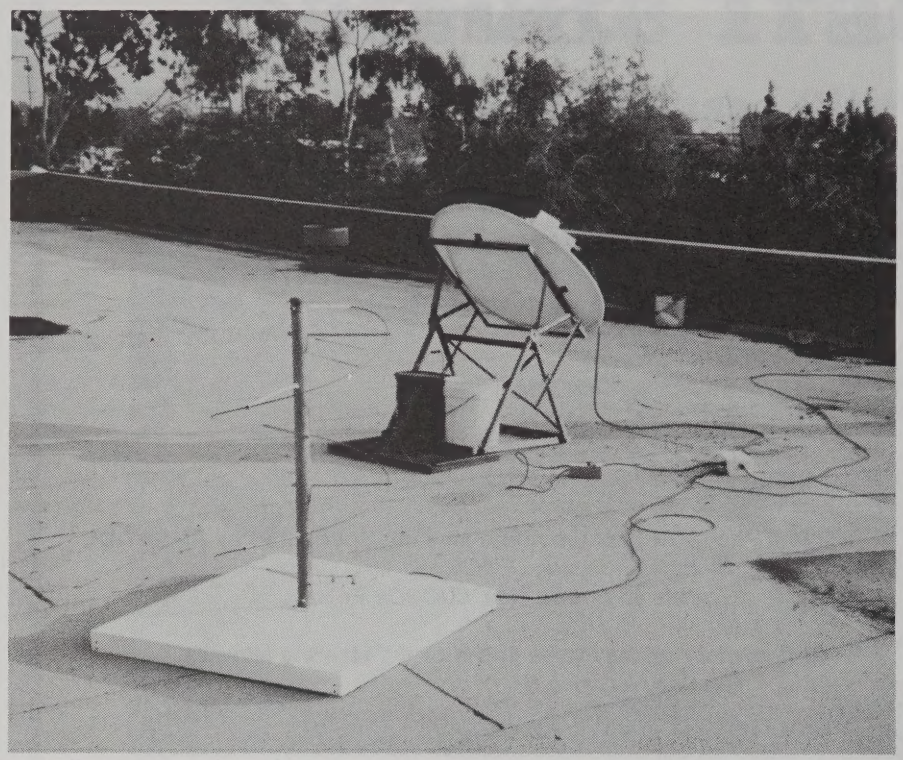
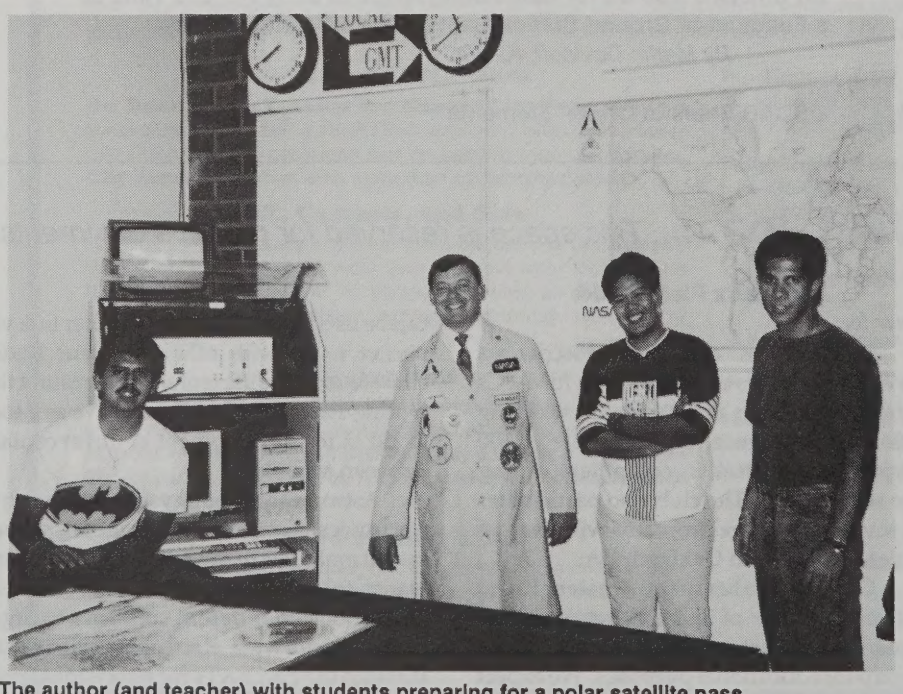


Parabolic and turnstyle antennas on the rooftop.

system alignment and again in each case, Mr. Page provided telephonic support. His recommendations included many adjustments not listed in the operators manuals.

As most technical problems have more than one solution, an effort was made to invite analysis from other viewpoints. Mr. John Arvedson and Mr. Duane Larsen (La Puente High School, CA.) were contacted for their input. Electronic bulletin board system (BBS) assistance was requested and provided by Dr. T.S. Kelso of RCM/P and Dr. Jeff Wallach of DRIG. Continuing telephonic technical assistance was provided by the manufacturer. Locally, Ed Murashie provided insight and words of encouragement.

The Educators Guide to Satellites, a technical report (*NESDIS 44*), was provided by NOAA and NASA. Polar calculators have been instrumental in allowing the students to predict the passes of polar satellites. A large world wall map was purchased and mounted along with two 24 hour format clocks. One set to PST and one set to GMT. Tracking programs furnished by AMSAT, "Orbits" by Dr. Tom Clark and "InstantTrack" by Franklin Antonio, provide a means for computer prediction of polar satellite arrival times.



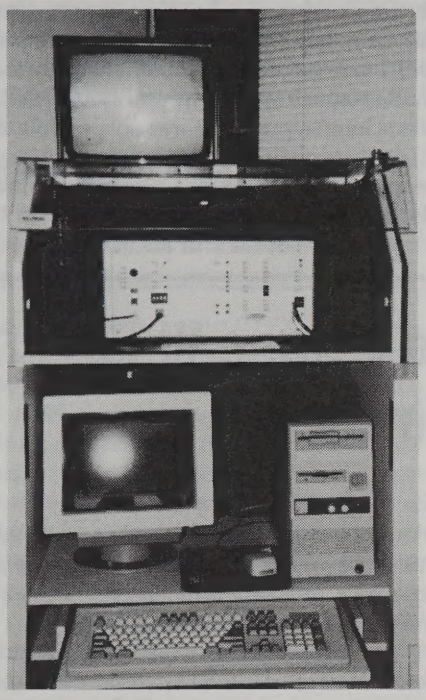
The author (and teacher) with students preparing for a polar satellite pass.

To date, five self-paced modules with supporting exercises have been written. They are: 1. Latitude & Longitude; 2. The 24 hour clock (GMT, UTC, ZULU); 3. Polar satellite predictions; 4. Operation of WSR513 during GOES transmission; 5. Operation of WSR513 during Polar transmission. In each case, an effort has been made to reinforce the theory with practical application using training aids and the Weather Satellite Receiver itself. The modules allow students to progress at their own pace towards an understanding of both geosynchronous and polar satellites, as well as operation of the Weather Satellite Receiver System.

The students have shown a keen interest in the tracking and reception of satellite signals from the very first day. They've been eager to complete each of the modules and have provided valuable insight on their improvement. At times it's been quite difficult to produce the modules fast enough to keep up with them. The first successful student operation of the equipment during a polar pass was really something to see. The entire class crowded around the monitor trying to see who could recognize the expected land masses first. As luck would have it, it was almost a perfect pass (900, directly overhead). They were so enthusiastic! It was really something to see!.

Since the school curriculum at ITT Technical Institute is 8 quarters long, and since satellite tracking is only taught in the 5th quarter, a club called "Sat-Trackers" was established. This allows students to remain active in satellite tracking as their education progresses and as the station grows. Many returning students, both currently enrolled and graduates, have requested they receive satellite training. As the station has only recently been reactivated, during their attendance of 5th quarter no comparable training was available.

Currently, we're having some successes and some failures with the polar satellite passes. Although the arrival times are fairly accurate, the window of reception is fairly short (3-6 minutes). The reason is that we're using a Omnidirectional antenna instead of a tracking antenna. The quality of the GOES reception varies from excellent to marginal during the day because our parabolic antenna is only 4ft. in diameter. But the system is working !!! With a recent grayscale EPROM upgrade from FeedBack Inc. (and another promised soon) the video resolu-



Equipment shown from the top: Satellite monitor, FeedBack weather receiver, VGA monitor, 386 mini tower, and keyboard.

Will it be Ascending or Descending?

tion of the WRS513 has been greatly improved.

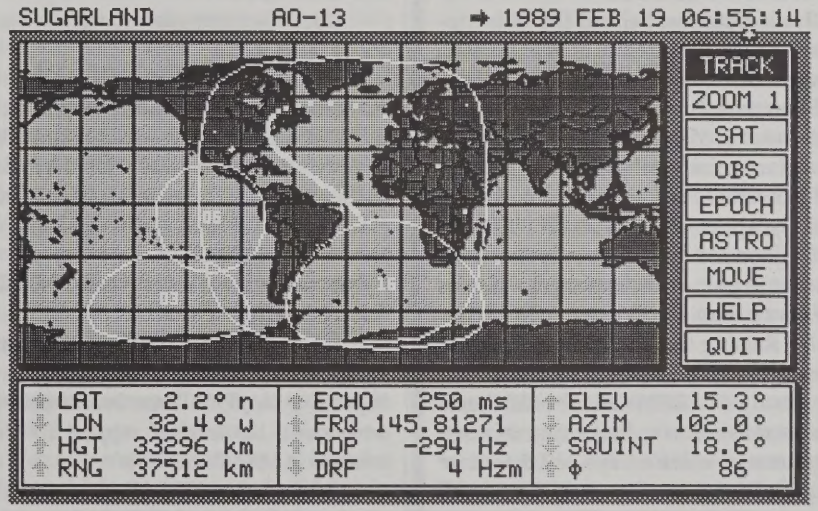
Most of the small problems should eventually be resolved. The larger ones, however, will need additional research and ingenuity. Most immediate is a method for long term storage of satellite images both from GOES and from NOAA-9/10/11. A tape interface module was acquired from FeedBack and we can now save polar satellite passes on a VCR on the audio track. This provides us with a unique teaching device, since the students can practice polar operation of the satellite receiver at any time. A 386/25 MHz dedicated computer has recently been purchased to be used specifically with the satellite receiver. The last and most obvious step is a computer interface module with software, but that's somewhere in the future.

Certainly a larger parabolic dish would go a long way towards cleaning up the GOES signal reception. Polar tracking is always a problem due to the movement of the satellites and the relative weakness of the signal. FeedBack may provide some help there in the future. We'll keep our fingers crossed.

As with most amateur projects the planners are likely to have more dreams than funds. So far, improvements have happened in stages, but we have come a long way. Certainly, the students have benefited a great deal and are a never ending source of ideas for making the modules more interesting. **Don't let anyone tell you the U.S.A.'s technical future is in jeopardy due to student malaise, in our lab "It just ain't so".** We're proud to help foster an interest in satellites and space during this decade, and into the next, at the ITT Technical Institute, West Covina, CA. ■

GET A BIRD'S EYE VIEW

From GrafTrak II™ and your IBM® PC



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The package includes an editor program used to construct and modify sat/obs data base files. In addition, a program to update data base files from bulletin boards, complete source code for a compatible rotator and receiver control program and several other utilities are included.

Requires an IBM PC, PC/XT, PC/AT, or true compatible, an IBM Color/Graphics Monitor Adaptor or true compatible, optional but recommended 80x87 math coprocessor, minimum 512K RAM, DOS 2.0 or later, and either two 360K floppy drives or one 360K floppy and one hard drive; the programs are not copy protected.

The complete package is $395 (List Price). Call for quotation. Check, money order, MasterCard, or VISA accepted.

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Initial Phase-3D Experimenters Meeting Sponsored by AMSAT-DL

Marburg, West Germany: May 7 - 9, 1990

Minutes by Peter Guelzow, DB2OS
Translated by
Don Moe, DJØHC/KE6MN

Since these minutes have appeared elsewhere in print, they have not been edited to confirm with the Journal's style.

Day 1. May 7, 1990

At 8:30 A.M. Karl Meinzer, DJ4ZC, opened the first Phase-3D experimenters' meeting, and after his initial greetings, he outlined the various items on the agenda for the following three days.

In general terms, DJ4ZC then explained the situation since 1988 after AMSAT-OSCAR 13 (P3C) was successfully put into operation and the reasons behind the decision to build a Phase-3D satellite. The Phase-3 series has shown the path into the future and proven that AMSAT is capable of developing and building quite complex satellites. DJ4ZC further emphasized the decisive role played by Amateur Radio satellites in the Amateur Radio service and how they have particularly contributed to technical advancements.

A basic criterion behind the development of a Phase-3D satellite is primarily an improvement in the link paths by at least 10 to 15 dB compared to OSCAR 10 and OSCAR 13. At most 8 dB can be achieved with improved antennas, so that the transponder output power would also need to be increased by approximately 7 dB. On the lower frequencies however, only 2 to 3 dB more antenna gain can be expected, whereas at SHF more than 10 dB extra gain is conceivable. Raising the transmitter power is thus one of the most important aspects, and a power budget of 200 Watts should therefore be used as a basis. In the case of a 300 Watt generator, solar arrays of 1.5 to 2 m^2 are required for a satellite stabilized in all three-axes. For a spin-stabilized satellite similar to OSCAR 13, the solar array area would have to be increased from 1 to 5 m^2, making the cost factor a very significant aspect.

Karl Meinzer pointed out that international cooperation is absolutely required on a project estimated to cost between 3 and 5 million DM (US$ 1.7 to $3 million). AMSAT-DL can provide 1.5 million DM (US$ 0.88 million) from resources of the West German Ministry for Research and Technology (BMFT).

Launch Opportunities

DJ4ZC then continued by outlining the current prospects for launching Phase-3D. In 1988 the USSR made AMSAT-DL an offer to place a 200 kg satellite directly into a Molniya orbit for $1 million DM (US$ 0.58 million). In this case a supplementary kick motor for raising apogee would not have been necessary. At that time, money was unfortunately not available, and since the BMFT was negotiating simultaneously for another launch opportunity for a joint USSR-West German project, it was not possible to make a reservation. Conceivably there may be another launch opportunity in the future along with a renewed offer from the USSR.

The development of the new Ariane-5 rocket is proceeding intensively, and two qualification test flights of the rocket with different missions are planned on which there is still free payload capacity. The first test flight is a launch into the geostationary transfer orbit (GTO). At this time this mission is already completely taken up by the Cluster satellites. The second test launch

Commentary on the Phase III-D Kick Off Meeting Minutes

By Bob McGwier, N4HY

As a result of the publication of the minutes of the Phase 3D Kickoff Meeting, on Compuserve, AMSAT and myself have had a storm of letters, notes, etc. requesting further information, wondering why we decided to do this and that, etc.

I am very happy to see these minutes written by Peter Guelzom, DB2OS as translated by Don Moe DJØHC/KE6MN published. These minutes brought out many details that I had forgotten about, and I am extremely grateful that Peter wrote them up, and Don translated them. ***It is perhaps not completely clear from the extremely detailed report that ALL THE ITEMS MENTIONED ARE STUDY ITEMS.***

Let me give you a few quick tips in summary on Peter's report:

(1) All items mentioned, and I do mean all, are STUDY items.

(2) AMSAT-NA is NOT against linear transponders. We volunteered to study the HELAPS for S band and to fund Matjaz Vidmar's parts procurement for him to do some of this work should we decide to fund all this. HELAPS is the method developed and implemented by AMSAT-DL in all of our linear transponders flown since AMSAT-OSCAR 7 (except in AMSAT-OSCAR 8).

(3) AMSAT-NA will be funding much of my activities if we join up on this project. I will be funding the digital experiments since I fully understand the level of support it "enjoys" amongst AMSAT members!

In no case has AMSAT-NA, AMSAT-DL, or anyone else cast ANYTHING into concrete except that we have an action item list of things to study and that we will meet again next spring or early summer at a place yet to be determined. ***You have plenty of time to comment, put your own thoughts into the process, contribute to the study items, etc.***

We have also had a rush of letters telling us, the directors of AMSAT, that we are elitist and that the Microsats are junk and we should never have done them and if we want continued support we should have Mode B forever. Have you listened to Mode B on OSCAR 13? While it does provide comunications capability, it does so in a marginal manner. I am sure that Mode B will fly in some capacity, but it will not be the primary payload simply because it is a physical impossibilty to fly the combination of antennas and power to meet our design goals for performance in a sustained manner on Mode B. This will mean that other transponders will greatly outperform it.

There are stated design goals for this new satellite in terms of performance and we will have to work extremely hard to get them on 70 cm, L band, and S band. Mode switching is a compromise, let's get rid of it. For these and other technical reasons, I will argue strongly that we should build the absolute best 70cm up or L band up and S band down system we can build and let that be the most complete system of transponders. Given that Mode B will not be able to achieve the same performance as these, I personally felt that we should not fly it. I was 'politically naive.'

On the digital modes your letters have complained so much about, I am proud to say I have managed to put together a team of very good microwave enthusiasts and I hope soon to enlist other digital and microwave talent to

will be into a low Earth orbit (LEO) as required later for flights of the space shuttle Hermes. In the meantime however, ESA plans to replace this flight with an additional GTO launch since there is much greater demand and the suitability for LEO flights would be automatically assured.

DJ4ZC is counting on the first GTO launch since the final decision about the Cluster flight is still open, leaving some chance yet. Karl is also hoping to reduce the costs of the launch campaign further. The current costing from Arianespace amount to approximately 2000 units per kilogram, thus nearly 2 million DM (US$ 1.2 million) for a 400 kg satellite.

Jan King, W3GEY, then provided an overview of the launch opportunities in the USA. Recently the Atlas rocket program has been expanded for flights with larger payloads into GTO. Since primarily only commercial flights are being planned, costs would be very high. The new Torus rocket should carry 450 kg into GTO and the first test flight is planned for 1994. There may possibly be a launch opportunity in this case, and Jan King and Bob McGwier, N4HY, intend to make further inquiries in this regard. As a result of increasing commercial interest and the ensuing higher costs, it is very difficult to locate any other openings. This also applies to the Titan-4 rocket, whereby two additional motor maneuvers are necessary to reach GTO due to the launch into LEO.

DJ4ZC would welcome a launch opportunity in the USA very much, but sees the best chances with the Ariane-5. The Ariane-4 would be out of the question since only a single satellite in the 200 kg class would be possible without triggering a very costly configuration change.

Andras (Bandi) Gschwind, HA5WH, reported about the contacts with DOSAAF and launch possibilities in the USSR and indicated that new prospects are opening up thanks to the political changes.

DJ4ZC recounted AMSAT-DL's cooperative effort with AMSAT-U-ORBITA and the Adventure Club on the construction of the RUDAK-II experiment and that further cooperation could be expected with them.

The next important item on the agenda was the financial situation. DJ4ZC emphasized that on principle each group must cover its own expenses. The solar generator and the rocket launch represent the major items in the total expense, whereby Karl Meinzer estimates the cost for just the satellite without solar panels at approximately 20%. The price for the solar generator from AEG-Telefunken amounts to nearly 600,000 DM! (US$ 353,000) Dick Jansson, WD4FAB, and Jan King, W3GEY, report that a 250 W bus design using SOLAREX solar cells was intended for a Phase-4 satellite, yielding an efficiency 22% better than before. Glass covers are available and the cost for 4.75 m² would only be US $130,000.

AMSAT-DL already has over 1.5 million DM for the Phase-3D project available and is hoping for additional support. It might be possible to raise an additional 600,000 DM from various universities wishing to include experiments of their own.

According to W3GEY. AMSAT-NA can make $150,000 to $200,000 available per year from the members. Virtually no funds can be expected from the government. AMSAT-NA will cover its own expenses in any event.

Hennie Rheeder, ZS6ALN, reported that AMSAT-SA will receive money from projects promoting education and from universities and will also cover its own expenses.

Alberto Zagni, I2KBD, related that AMSAT-I was able to raise US$ 100,000 from donations for the Microsat project and sees a good chance that not only can it cover its own costs but also contribute to the entire project.

There are currently three groups active in AMSAT-VK. Furthermore there is a possibility to obtain Aus $100,000 to 250,000 from the government. The problem is that this money is reserved for an Australian payload and must remain within the country.

work with the team on a DESIGN experiment. This transponder, to this very moment, is funded by N4HY not AMSAT. Its operation will not interfere with the use of the linear transponders in the way I envision its use. This is because it will only be on during a short time around apogee and with severely limited access by designated ground stations who can deliver packet traffic to their local areas (here local area means continents and large countries!).

At this fall's AMSAT-NA Annual Meeting, the newly constituted board of directors will take up III-D as a future project and vote at that time whether or not to commit to it. I suggest if you like what is implied in Peter's extremely nice report, you write to your directors and show your support. If you are opposed then of course, write and tell them that you are opposed. We are your elected representatives and we want a new project to take AMSAT into the future. While I believe this is the one we should do, I also believe that we need to hear from you.

Let me close with a few final points. When Mode B was first introduced on AMSAT-OSCAR 7, there were only about two 70 cm transverters and very few 70 cm multi-mode rigs available. It may be that the current availability of equipment that makes Mode B so desirable is a result of flying that first transponder on AMSAT-OSCAR 7. In a similar manner, as the use of the L and S band frequencies become popular commercial equipment will become available.

If we fly S band and L band transponders on the spacecraft, that does not necessarily mean that you, the user will have to be equipped for those bands. Have you forgotten the gateway concept? There's a fascinating opportunity for experimentation by Radio Clubs. What about the design and building of a Mode B to S/L band terrestrial gateway? For amateurs in metropolitan areas, such gateways could provide the best of both worlds. We get Microwaves on the up and downlink, you get Mode B with simple fixed antennas and no tracking problems. I assure you that unless AMSAT-DL (read that Werner Haas) refuses to build a Mode B transponder, it will be on board Phase III-D. This 'open letter to the readers' is not the place to go into a technical discussion of why Mode B CANNOT be the primary transponder on Phase III-D. I plan to put together an article for the Journal, *with the help of the others involved, showing why this transponder cannot meet the same operating conditions as Mode LS can. The short answer is that we cannot fly antennas that are big enough because we are a piggy back customer and cannot co-opt enough space inside the bird.* ***Please don't feel we are abandoning you, that is NOT what is happening. I send you my personal apologies for your misunderstanding of what was said, what has gone on in the past, what is planned for the future.*** *I also wish to let you know that I am as deeply disturbed by the lack of progress on the Microsats as you are. If there were ANY way for me to rectify the situation I would. I am shut out of the process by circumstances and I can only promise you, it will never happen again if I am to be involved. Am I opposed to Mode B? Well, let me put it this way. As I go over 100 countries and earn my satellite DXCC, you will see me on Mode B quite a bit. Do I wish to throw away the possibility for advancement on our next bird if that is the ONLY way to get Mode B? The answer is no, I do not. It is my opinion, based on technical considerations, that you will wish to operate Mode LS on the next bird since it will outperform Mode B. It will outperform it by as much as 10 dB and it is more likely to be 20 dB. This is not because we will not try to give you the best Mode B we can. It is because of the laws of physics, and the realities of how we get launches and because high gain antennas for S band are just plain easier and cheaper to build for you the ground station than large 2 meter antennas. See you on the birds.* ■

From the University of Budapest in Hungary, Bandi Gschwind, HA5WH, is certainly willing to take on a project but has problems obtaining components and money.

Project OSCAR would like to participate in the Phase-3D project by donating hardware and money and could thereby support HA5WH, for example.

According to James Miller, G3RUH, AMSAT-UK can contribute nearly 25,000 (US $42,000) yearly. Such things as hardware, etc., are not likely to be forthcoming however.

The JARL/JAMSAT might also be enticed into contributing financially. DJ4ZC may travel to Japan and negotiate with the JARL.

In Germany, DJ4ZC expects a certain degree of difficulty in obtaining money from scientific organizations or institutions since the conflicting interests could complicate matters relative to the BMFT.

W3GEY sees rather good chances of obtaining hardware donations since the industry has a major interest in qualifying products for space flight. DJ4ZC considers this to be very important and welcome, particularly in the area of navigation sensors for a three-axis stabilized satellite.

Tasks and Goals

In 1992 the WARC will be taking place and among other items will consider the Amateur Radio frequency allocations. In light of an international Phase-3D satellite project, the prospects would also be good for retaining microwave bands (500 MHz to 3 GHz).

Presentations at local and IARU events are strongly suggested. AMSAT-International should also participate in the WARC. A working group should be formed that can devote its attention to this matter.

Once again DJ4ZC emphasized the retention of the frequencies but also sees the personal motivation of each individual participant on the project. Besides the urge to do research, there is a certain degree of stimulation from working together on such a project, since it is done without payment and during free time!

Since the lifetime of the satellite should be around 10 years, we must consider today which modes of operation will be in the greatest demand in 10 years time. Doubtless these will include the digital operating modes. "The world is going digital" and everything will change. Besides the normal analog transponders, such as for Mode S, digital transponders must be seriously considered for such modes as high-speed digital picture and voice transmission. On the other hand, the fact cannot be overlooked that a Mode B station is already a maximum for many radio Amateurs and they want a simple station. The Phase-3D satellite must thus provide for both simple operating possibilities and the highly technical requirements of microwave transponders and digital payloads.

Alberto Zagni, I2KBD, commented that various institutions could provide significant sums for ecological experiments and that this might be a worthwhile goal.

Hennie Rheeder, ZS6ALN, briefly outlined the goals in building the AMSAT-SA experiment for 29 MHz which is to allow educational bulletins transmitted in SSB compatible amplitude modulation to be received using simple converters. The high-frequency "Sounding and Atmospheric Experiment" aims at aiding scientific research into wave propagation. Furthermore, this would also provide a means of activating the 29 MHz band during the solar minimum and thus retaining it.

DJ4ZC reported on his conversations with the DARC (German Amateur Radio Society) and that he came away with mixed feelings, presumably because there is currently no one capable of participating in such a project. HA5WH mentioned the great interest of the IARU in broadcasting bulletins. The problem there as well as at the DARC is who would write the bulletins and then load them into the satellite.

Orbits

After a short break, Jan King, W3GEY, made a presentation about the alternatives to the Molniya orbit currently used by OSCAR 13. A major problem is the relatively poor accessibility to the satellite from the southern hemisphere of the Earth. Therefore, W3GEY theoretically analyzed various modifications which could possibly improve the situation. Shifting the argument of perigee by nearly 30 degrees from apogee does not provide any noticeable advantage.

Table 1 — 5/3 Molniya Orbit Summary by Jan King

Perigee height	8086.0 km
Apogee height	39142.6 km
Period	718.0 min
Mean Motion	1.667 rev/day (5 orbits in 3 days)
Semi Major Axis	29992.5 km
Eccentricity	0.51774
Inclination	63.4349 deg
Arg of Perigee	270.0 deg
RAAN	270.0 deg
delta V	472 m/sec (True Molniya -> 5/3 Molniya)

Stable Apogees

Apogee #	*Longitude*	*Coverage*
1	2.5 deg	8.25h @ 40 deg N, 100 deg W
2	146.2 deg	7.25h
3	-70.4 deg	12.5h
4	+73.0 deg	3.75h
5	-142.2 deg	12.5h

A significant improvement and good access from the southern hemisphere can be achieved in a true Molniya orbit at 63x inclination by raising the perigee to nearly 8000 km altitude. The orbital parameters could be optimized to the extent that over a three day interval five stable apogee positions result. Since the apogee does not drift, fixed antennas could be installed on the ground for operation at apogee. See Table 1.

DJ4ZC suggested that the orbit period might also be optimized if possible such that the local apogee would be sun-synchronous, hence always between the same hours locally, such as from 16:00 to 23:00.

Furthermore a long-duration analysis is necessary for Phase-3D to ascertain the effects of the perturbations from the Sun, Moon and Earth on the orbit. This was prompted by a reliable study by Victor Kudielka, OE1VKW, which showed that OSCAR 13 will reenter and burn up in the period 1995-1997.[1]

(See his article in *AMSAT-DL Journal*, June/August 1990.) Due to its different parameters, the orbit of OSCAR 10 is not in jeopardy.

Dr. Victor W. Kudielka, OE1VKW
Peter-Jordan-Str.165
A-1180 Vienna, Austria

A working group "ORBIT" should be established to work on optimizing the orbit for Phase-3D. Suggested were W3GEY, N4HY, OE1VKW, DL2MDL, and G3RUH.

Then DJ4ZC elaborated on the properties of the plasma (water) rocket motor, which requires approximately 350 Watts of electrical power to provide a thrust of 100 mN with an ISP of 4 to 5 m/s at 30 mg/s. This thruster could be used to fine tune the orbit, assuming it is even feasible.

An alternative would be another 400N motor from MBB, such as was successfully used in OSCAR 10 and OSCAR 13. AMSAT-DL is hoping to obtain another such motor from MBB.

On the other hand, the safety procedures during the launch campaign are very critical and also quite expensive. Using a water thruster would simplify many aspects.

In order to achieve the final orbit, approximately 6 months would be necessary and the orbital maneuver would automatically be performed at apogee for 2 hours each time. At this time a vacuum test chamber is urgently needed for testing the motor. The power for the motor could be supplied from 300 A/h, 26V NiH batteries from the USA.

[1] See AMSAT Journal, *Vol. 13, No. 3, July 1990.*

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Since the orbit of the satellite would be constantly changing, new navigational procedures and methods of orbit determination are also mandatory.

In order not to overtax the command stations, a goal should be that command station interaction is required at most once per week. Over a time period lasting more than 6 months, this would otherwise be an excessive burden on the command stations.

Transponders

DJ4ZC then asked the various groups to describe their ideas to the other participants.

N4HY explained the interest of AMSAT-NA in developing a high-power wide band digital transponder with a 23 cm uplink and 13 cm downlink (Mode S) for packet radio interlinking and digital video transmission at a maximum of 1.5 Mbit/s and a minimum of 64 Kbit/s.

The RUDAK group will implement a digital transponder with several uplinks based on RUDAK 2 and the RTX2000 processor. There was not enough time to prepare a concrete proposal for the project prior to this meeting. The basic intention is to develop and build something along these lines.

DJ4ZC explained that based on a guideline of 350 bit/s per Watt EIRP, approximately 64 KBit are achievable. 5 dB could be gained by additional encoding, resulting in a total gain of 20 dB, 15 dB from better links and 3 dB more transmitter power = 2 Watts.

The 29 MHz beacon in the experiment from AMSAT-SA could have more than the requested 50 Watts. 100 Watts at perigee are also no problem, although heat pipes are necessary for removing the excess heat. Dick Jansson, WD4FAB, indicated that these are available. The question arose at this point about how heat pipes might affect the rotation of the satellite.

AMSAT-IT has no specific suggestions, but would gladly participate in the "digital" corner.

Knut Brenndoerfer, DF8CA, suggested building an X-band analog transponder with a 10 GHz downlink. Output power of 20 Watts with high antenna gain would support a bandwidth of 50 to 100 kHz.

Materials and converters could be inexpensively obtained and adapted from receiving equipment for the direct broadcasting TV satellites (DBS).

A bigger problem is the precise tracking with the receiving antenna. Transmitter transistors are meanwhile available for prices around 2,000 DM each (US$ 1,176.50). Further calculations on the link budget must still be performed.

Following the lunch break, Karl Meinzer, DJ4ZC, presented the results of a survey from the most recent AMSAT-DL members' meeting about which transponders are desired. See Table 2 on the next page.

The results indicate that there is a significant interest in a high power 2 Meter downlink with a 70 cm uplink (Mode B). Especially notable is the strong interest in an additional 13 cm downlink (Mode S). Interest in Mode L is rather low, which is also indicated by the meager activity via OSCAR 13. The Mode J transponder was essentially rejected, presumably due to the opposition from the IARU.

James Miller, G3RUH, then reviewed the survey conducted by AMSAT-UK, which essentially concurs with AMSAT-DL's survey.

The survey by AMSAT-NA was not available at this moment, but no Mode B transponder had been planned for the Phase-

Table 2 — Survey results from a recent AMSAT-DL members meeting.

Mode	For	Don't care	Against	
29 MHz DOWN	30 %	30 %	30 %	
50 MHz DOWN	30 %	20 %	40 %	
145 MHz DOWN	75 %	20 %	5 %	Mode-B
435 MHz DOWN	70 %	20 %	10 %	
145 MHz UP	0 %	30 %	70 %	
435 MHz UP	95 %	5 %	0 %	Mode-B
24 cm UP	30 %	65 %	5 %	
13 cm DOWN	70 %	30 %	0 %	Mode-S

4 satellite.

DJ4ZC elaborated on the design of the LEILA system in the transponder to detect and suppress excessively strong stations. At first such a signal would be marked with a CW beep. If this warning does not prove adequate, the signal would be distorted and attenuated by a notch filter. The on board computer will perform this task and will be able to monitor several signals simultaneously. The expected gain should amount to around 10 dB, since the AGC for OSCAR 10 was constantly in the range of 10 to 20 dB.

Peter Guelzow, DB2OS, mentioned that the required transmitter power on the ground is the greatest problem for Mode L. Particularly the cable attenuation over longer runs has proven to be the biggest hindrance and many OM's are not willing to buy or build an expensive power amplifier in addition to an expensive transceiver.

Conversely, installing a 13 cm converter directly at the antenna, in a manner similar to a preamplifier, is a relatively simple matter in comparison. DB2OS said furthermore that the transponders should be compatible to each other. Transponder time tables as currently practiced with OSCAR 13, are quite unsatisfactory in the view of both the users and the command stations. Ideally the transponders should be operable simultaneously and continually and should adjust their power output level to conform to the available power budget.

The subsequent discussion about the transponders sometimes became quite controversial, particularly concerning the Mode B and Model L transponders, so that a final decision should be made at a later time. Instead the subject of "who builds what" was tackled.

AMSAT-NA wants to build a hard-limiting digital transponder with a 23 cm uplink and 13 cm downlink (N4HY) and a high-power S-band linear transponder using the HELAPS technique (W3GEY and Matjaz Vitmar, YT3MV).

YT3MV and Josef Koeferl, DC9RK, announced interest in developing a Mode S transmitter. YT3MV also wants to perform the link calculations for the Mode X transponder.

DF8CA and Hermann Hagn, DK8CI, want to pursue the design of a Mode X transponder further. N4HY has contacts to other groups involved with 10 GHz that may also be interested.

YT3MV would like to develop a 24 GHz beacon with 100 mW output power.

AMSAT-SA will build the 29 MHz beacon experiment.

Werner Haas, DJ5KQ, would take over construction of Mode B and LEILA at AMSAT-DL.

Antennas

A decisive factor in the transponder configuration is the question of the antennas, which then is dependent on the structure of the satellite, either a spin-stabilized ring or a three-axis stabilized box design.

Non-transponder Experiments

JAMSAT has suggested including a multi-spectral CCD camera for Earth observation. At 500 pixels the resolution should be approximately 20 km. A proposal is being requested.

The 29 MHz ionospheric experiment from AMSAT-SA is also in this category.

At 17:42 Karl Meinzer closed the first working session.

Day 2. May 8, 1990:

The second working session was opened by Karl Meinzer, DJ4ZC.

Spacecraft Design

The suggestion by W3GEY to raise the perigee to 8,000 km should be investigated further, in particular in regards to eclipses, sun angles, tracking the solar panels, etc.

DJ4ZC would like to have the physical details clarified this year!

Antennas

DJ4ZC reviewed the antenna situation using some specific numbers:

S/C antenna platform 1m x 1m = $1m^2$ (AO-10 & AO-13) —> 1.3m x 1.3m = $2m^2$ (P3D)

Isotropic antenna area:

$$\frac{\text{Lambda}^2}{4\ \text{Pi}}$$

20 dB antenna area:

$$\frac{12 * 100}{4\ \text{Pi}}$$

—> Required area = $\frac{3 \times 3\ \text{Lambda}}{}$

2m : Impossible
70cm: 13 dBi Gain
24cm: 20 dBi gain possible

Based on these numbers, DJ4ZC showed that it becomes easier to achieve higher gain from the antennas as the frequency increases. On 2 meters this is a difficult situation so that the only way to improve the downlink gain in comparison to OSCAR 13 is to radically increase the transmitter power.

In the following (See Table 3), DJ4ZC presented approximate link calculations to show how much transmitter power is required for the signal to be 20 dB S/N at the ground at a distance of 40,000 km.

After further discussion the transponder question still remained controversial

Table 3 — Approximate link calculations showing how much transmitter power is required for the signal to be 20 dB S/N at the ground at a distance of 40,000 km.

Band	29	145	435	1296	2400	10.5	
S/C Ant Gain	0	6	15	18	18	18	dBi
Gnd Ant Gain	-3	3	3	5	20	33	dBi
Noise Temp.	2000	500	500	300	200	200	xK
Path Loss	154	168	177	186	192	205	dB
Power for 20 dB S/N in 20 kHz	100	12.5	12.5	18	2	2	Watts

and should be discussed further in the individual groups. The final decision should be made at the next meeting. The request was made however, not to include too many different transponder modes and to keep them as compatible to each other as possible, such as Mode B and Mode S simultaneously. Mode L and Mode B would be mutually exclusive however, such as on AO-13.

The fundamental question is whether to use 70 cm for the uplink or the downlink. DF8CA suggested using only 70 cm for the uplink in order to supply the diverse downlinks from 2 m to 10 GHz from it.

HA5WH was requested to pass an offer along to the DOSAAF satellite group to build a high power Mode B.

Furthermore, an application should be made to the IARU/WARC to allow the 23 cm band to be used as a downlink band also. Presently Amateur Radio satellites may only use this band for an uplink.

POWER SUBSYSTEM

Solar Generator

On a three-axis stabilized satellite approximately 2 m^2 of solar panels will be needed. The solar cells from SOLAREX would provide nearly 280 Watts at 15% efficiency. The panel configuration needs to be studied, in particular whether the solar cells should be mechanically oriented towards the Sun. Would 2 or 3 momentum wheels suffice for attitude control or would a ball wheel be superior?

After a rough estimate, it seems to be more sensible to employ larger solar arrays instead of adjustable panels. The mechanical aspect, such as cable connections, etc., are very critical. WD4FAB will investigate various possibilities, such as 45 degree or fully articulated 360° tracking with the panels. The goal is nearly 200 Watts of power at 28 V bus voltage. (BCR by HA5WH)

Batteries

From experience two batteries will be required in all. The suggestion was made to use the NiCad battery for the plasma thruster and the NiH battery for supplying the transponder. Another possibility is to use the NiH battery for the first 5 years and thereafter the NiCad battery. AMSAT-DL has been in contact with SAFT, but the prices are quite high. AMSAT-NA can obtain bargain cells from GTE. The cells are now nearly 5 years old, but in good condition. Of the currently available cells, 40 need to be selected and stored. Each cell costs US$ 20; out of every 5 cells only one is usable, so that the entire battery would cost US$ 4000. WD4FAB is the contact person for the NiH battery.

IHU

For safety reasons, the COSMAC 1802 CPU should definitely be employed due to its very good track record since the IHU is a vital element for the entire satellite. No other CPU has yet been qualified for such an orbit. A correspondingly radiation hardened CPU from SANDIA is on hand. However, the processor board should be redesigned to incorporate the memory on the main board also. The prices for radiation hardened RAM components are very high, in the vicinity of US$ 85,000. Possibly the results from the memories in RUDAK-II should be evaluated first.

Bob McGwier, N4HY, stated his willingness to take over the redesign of the IHU. The command input/output arrangement should be retained as in the past, i.e. Atari 800XL running IPS at the ground station and with the same protocol as with AO-13. At this juncture, the desire was expressed to have a diskette drive attached to the Atari 800XL since the operation with a cassette recorder is quite unsatisfactory. DB2OS explained how he makes due without a cassette recorder by connecting the Atari 800XL with an Atari 520ST. Thanks to software written by Stefan Eckart, DL2MDL, the Atari 800XL can be booted with the IPS GS software and IPS blocks can be transferred at 2400 Bit/s between the two computers. Program sections and text can be edited and stored on the Atari ST and then passed via the RS-232 port to the Atari 800XL. In principle, it would also be possible to make a similar arrangement with a PC, but someone has to write the software. In the meanwhile the Atari 800XL product line has been expanded with newer compatible models so that suitable computers will also be available in the future. The advantage of this computer is the low interference level compared to other computers where the interference makes reception of the signals from the satellite virtually impossible.

Back to the design of the IHU on board computer, Hanspeter Kuhlen, DK1YQ, recommended a hardware command decoder in order to be able to bypass the computer in an emergency. For RUDAK II a hardware command decoder was incorporated in order to be independent of the RS ground station and to avoid having to use their command system. DJ4ZC is absolutely against such a system since in his view the danger of a mistake thereby increases dramatically. Instead he would rather install a second standby on board computer in the satellite, perhaps using the RTX2000. Going into great detail, Karl Meinzer then explained the disadvantages and dangers of excessive redundancy. For example, it must be impossible for the hardware command decoder and the computer to work against each other and thus become blocked. In the past, numerous satellites have experienced serious problems and near losses due to such occurrences. DB2OS referred to the experiences with OSCAR 10. Despite the defective on board computer, the satellite is still quite popular when enough power is available to supply the transponder. If it were possible to switch off the transponder during periods of poor sun angles or eclipses, the lifetime of the battery could doubtless be extended significantly. DJ4ZC commented that the computer is vital for the functioning of the satellite and in the case of a total failure, the satellite would become virtually useless due to the lack of attitude control, and it would thus be better to switch it off entirely. After an extensive discussion, a very simple hardware command system was agreed upon, in which perhaps only the transponder could be switched on and off. DJ4ZC would like to see such a system successfully demonstrated, as aboard RUDAK II, and to study the circuitry very carefully.

Another aspect is the electrical wiring in the satellite. Should a central multiplexer module, as presently used, or a new ring-bus design be chosen? N4HY and W3GEY explained the bus design using the Motorola AART component in the Microsat satellites. Thanks to this bus system the otherwise mandatory cable harness could be essentially eliminated and placing the individual modules into operation proved to be significantly simpler. The suggestion was made to use a module controller, such as the 68HC11 MCU, which passes the telemetry to the IHU via a serial bus. W3GEY is of the opinion that suitably radiation hardened components could be obtained. DJ4ZC will prepare a specification with the requirements for the telemetry and other physical details and among other things check into the suitability of star or ring-shaped networks. The telemetry should provide approximately 128 analog measurements per second. 256 digital status points are planned for each input and output. The data should probably be available on the internal bus every 20 milliseconds. The battery charge regulator (BCR) should have its own telemetry unit. N4HY, W3GEY, DG2CV, and DB2OS plan to examine the topics of IHU, module controller and ring bus and to develop suitable concepts.

Propulsion

If the 400N motor from MBB is used, a 150 liter tank for the dual-propellant fuel will be required. Questions and ideas regarding the tank design will be clarified by Dick Jansson, WD4FAB, and Dick Daniels, W4PUJ. According to DK8CI, there is

someone at the University of Munich who would like to become involved in perfecting DJ4ZC's plasma thruster. Another possibility is the ion thruster RITA at the University of Giessen. The thrust from this motor amounts to nearly 10 mN at a required power level of nearly 400 Watts.

YT3MV suggested an electrostatic fluid control system for the tank, whereby the propellant could be pushed towards the outlet pipes by taking appropriate advantage of the dielectric properties. Since there is no rotation, a suitable technique must be found that will empty the tank completely. DJ4ZC suggested a propeller, but since the propellant is chemically very aggressive, it is not yet clear how this could be achieved and with what kind of material. In the electrostatic method, a very high voltage may be necessary. Instead of the triangular design proposed by YT3MV, Karl considers a long cylinder shape with outlet openings to be a solution. DB2OS suggested perhaps using the high voltage to operate a travelling wave tube on S or X band. YT3MV was requested to prepare an analysis of this technique and to determine whether the necessary high voltage may be too high. Such a concept could really only be applied without hesitation to a water thruster. Possibly the rotating field from the magnetic coils inside the satellite could be used to cause the propellant to rotate by adding small iron particles. Another solution would be to employ the method previously used on AO-10 and AO-13: let the satellite rotate during the initial motor burns and then switch to a 3-axis stabilized attitude.

Separation System

Two systems are available: Super-ZIP cord and clamp band. Super-ZIP is very expensive, nearly 100,000 DM (US $59,000), but it was employed on the cylindrical adapter for OSCAR 13 and functioned successfully. A rope-like explosive band is mounted along a designated separation line and separates both sections after ignition. Martin Sweeting had built a clamp band himself for UoSAT and thus it seems likely that it could likewise be built for Phase-3D. Conceivable is also a 3 point mounting with explosive bolts. DJ4ZC wants to negotiate with ESA to determine the best solution for all parties involved.

Structure

Following the lunch break, Dick Jansson, WD4FAB, reported on the satellite frame and the thermal design of the Phase-IV structure. Using extensive overhead slides, he showed how the assembly of the structure proceeded for the Phase-4 model. At this time a model of the folding satellite antennas is being built at Weber State University in Utah. Furthermore WD4FAB explained the design of the antennas, the heat pipes and how the solar panels are mounted to the satellite structure. Much of the expertise and preparatory work for the Phase-4 study can be adopted for use in Phase-3D.

Karl Meinzer, DJ4ZC, thanked Dick Jansson for the very interesting presentation. If the final decision falls in favor of the ring shaped satellite structure, then WD4FAB should take over the leadership in constructing the structure. A three-axis structure requires a completely new design.

Therefore it will be necessary to clarify with ESA before the end of the year which kind of satellite should be chosen. In the case of a three-axis design, the entire upper payload position would be needed.

Dick Jansson, WD4FAB, has already performed extensive thermal design studies by computer. As soon as the decision on the structure has been made, he would then calculate the complete thermal design for Phase-3D.

Another point regarding the antennas: AMSAT-NA will investigate antenna configurations with switchable radiation patterns. DJ4ZC also wants to give some thought to the matter.

Attitude Control - Sensors

DJ4ZC described which sensors are needed for Phase-3D. On a three-axis stabilized satellite, an Earth sensor as well as a precise Sun sensor are essential. Additional sun sensors with lesser accuracy must be mounted on all four sides of the satellite in order to measure 360 degrees. On each side a sensor will be installed with a orifice angle of ±45°. In any case, only static sensors having no moving parts will be mounted. A CCD camera could also be a possible solution. Its price is around 600 DM (US $350). According to YT3MV, a 500x500 CCD array from Valvo costs only 80 DM (US $47) and the dynamic range is around 40 dB. Four of such CCD arrays would be needed. Infrared detectors might also possibly be practicable as Earth sensors, but there are some other problems here. All participants were asked to be on the lookout for reasonably priced sensors.

DJ4ZC listed the specifications of the sensors as follows:

Sun sensor:	90 deg x 90 deg visibility, 0.5 deg resolution (±45) x (±45)
Earth sensor:	the same, but 1 deg. resolution

New sensor electronics will also have to be developed. W3GEY and HA5WH offered their services to build the SEU.

Momentum Storage

DJ4ZC will investigate various methods of storing momentum. Among others, there is the conventional method with momentum wheels, then magnetically isolated momentum wheels (Robinson, Estec), the ball concept (DJ4ZC) and fluid momentum control (WD4FAB). Jan King, W3GEY, will undertake a study of fluid momentum control in regards to the total mass, the maximal steerable momentum and the power consumption.

Magnetic Reaction

The location and design of the magnetic coils can only be determined after the structure design is completed. The power consumption will be in the same range as on OSCAR 13. Since the intensity of the Earth's magnetic field at 8000 KM perigee altitude is only about 1/10 that in a very low Earth orbit, the orbital maneuvers will take nearly 8 times as long as for OSCAR 13.

Solar Generator

Dick Jansson, WD4FAB, knows a specialist who has experience in the areas of deployment and control. He could also investigate whether fully rotating panels are feasible.

Broadcast Transponder

Hennie Rheeder, ZS6ALN, made an extensive presentation about the 29 MHz broadcast transponder planned by AMSAT-SA. The modulation should be amplitude-compatible SSB (single-sideband with carrier), so that the downlink signals can be received with a normal AM broadcast receiver as well as with normal SSB equipment. A store and forward voice output is planned in which approximately four to six megabytes of RAM would provide nearly 15 minutes of speech. The uplink takes place via an analog/digital converter, the downlink via a corresponding D/A converter. N4HY suggested a 4 bit PCM modulation for the downlink such as in DOVE-OSCAR 17. DJ4ZC recommended suppressing the carrier and only adding it to the audio signal during broadcast transmissions. In this way, all kinds of modulation could be tried, even Karl's RSM modulation.

The uplink should preferably take place on 70 cm in FM or digital AFSK, whereby the signals would be digitized and prepared on the ground. Using block diagrams, ZS6ALN provided an overview of the hardware design. DJ4ZC spotted several problems in the design with feedback coupling and provided some tips on how to avoid HF feedback. HF could be coupled from the transmitter back into the oscillator and buffer. Through use of a modulator at

2 MHz and a subsequent mixing, this problem could be avoided. A power level of 50 Watts EIRP at perigee would suffice, but DJ4ZC suggested 100 to 200 Watts which would be quite good at perigee and could readily be made available. DJ4ZC specified further restrictions: the mass of the experiment could only amount to 5 to at most 10 kg and the volume between 5 and 10 liters. The activation period would be 1 hour with 200 Watt PEP input power. The transmitter should operate linearly according to the HELAPS principle, thus resulting in a peak input power of 200 Watts and an average input power of 20 Watts. The downlink would be around 29 MHz, but the exact frequency must yet be coordinated. The uplink would take place in the 70 cm or 23 cm bands. The temperatures normally range between 0° and 10° Celsius, maximally between -20° and +40°. During thermal vacuum testing, the temperature will be cycled through a range from -25° to +50° Celsius. The minimal demands regarding the vibration test are comparable to the vibrations in an automobile.

The transmit antenna should be made from non-rusting steel tape, comparable to rolled up measuring tapes. A prototype of the experiment should be completed by mid-1991, according to ZS6ALN.

Day 3. May 9, 1990

After punctually opening the last working session, DJ4ZC went back to the subject of flight attitude control. The "reaction wheel" system also needs a sensor to measure the angular acceleration. Someone needs to look into the various sensor types for measuring brief time intervals. The flight attitude sensors can be used for long time intervals. DJ4ZC outlined two different techniques, one is a laser gyro method whereby the technology might be available from a CD player, and the other is a so-called "wine glass" gyro, in which mechanical oscillations are generated and then measured.

Work commitments:

On the final day, the assignment of the various tasks topped the agenda. DJ4ZC systematically went through a list of the individual units in the satellite and the following work groups and contact persons were determined:

Transponders

AMSAT-NA (N4HY, W3GEY): Mode L to Mode S (23cm/13cm). HELAPS S transmitter, hard limiting digital transponder. Analysis of required power and efficiency.

YT3MV and DC9RK: high power Mode S transponder, analysis of Mode X. Components via AMSAT-NA.

AMSAT-DL (DK8CI, DF8CA): Mode X design study.

AMSAT-SA (ZS6ALN): 29 MHz experiment and high power transmitter.

AMSAT-I (I2KBD): L-band receiver.

AMSAT-DL (DJ5KQ): Transponder, Mode B, Mode L, LEILA.

HA5WH: "USSR" Mode B transponder.

JAMSAT: 29 MHz "parrot", same frequency digipeat, inter-satellite communication. Proposal expected.

RUDAK: Proposal expected.

Non-Transponder Payloads

JAMSAT: CCD camera, proposal expected.

YT3MV: Picture transmission standard for CCD camera.

WEBER (WD4FAB): T.B.A., impact, radiation sensors. Proposal expected.

AMSAT-SA (ZS6ALN): Ionospheric experiment, including rest of transponder.

AMSAT-VK (VK5AGR): Proposal expected.

Solar Generators

WD4FAB: deployable array, including mechanical control.

W3GEY: Costing.

BCR

HA5WH: BCR design.

Batteries

WD4FAB: NiH battery.

W3GEY: NiCad battery, selection of 2*20 cells.

IHU

N4HY: IHU 1802 design.

N4HY, DG2CV, DB2OS: internal bus architecture and module controller.

Propulsion

DK8CI: Inquire at University of Munich about motor development.

DJ4ZC, W4PUJ: Tank, volume constraints, supply system.

YT3MV: Electrostatic fuel delivery.

DJ4ZC: Investigate MBB 400N motor.

DJ4ZC: Tank production.

Attitude Control

HA5WH: SEU

W3GEY: to look for cheap sensors.

Momentum storage

WD4FAB: Summarize fluid control system.

DJ4ZC: study magnetic wheels.

WD4FAB: solar stuff constraints. (??)

Thermal Design

WD4FAB: Thermal study, solar panels. Define structure constraints.

Structure

WD4FAB: Weber State University.

Antennas

W3GEY suggests measuring the antennas this time on a test range.

DJ4ZC: Identify antenna contractor and constraints.

WD4FAB: Identify antenna contractor.

Separation System

WD4FAB: Fabrication of 1 m mount clamp.

DJ4ZC: AR-5 user manual to WD4FAB.

Orbits

G3RUH, W3GEY, N4HY, DL2MDL, VK5AGR: Orbit problems, orbital studies.

DJ4ZC: Long term study paper from OE1VKW to DJØHC.

DJØHC: Translations.

Attitude

G3RUH: Pointing angle and sun angle studies.

DJ4ZC: Sensor constraints.

N4HY: Solar array control trade-offs, illumination.

Launch opportunities

DJ4ZC: Investigate launch with ESA.

HA5WH: USSR launch possibilities.

VK5AGR: Chinese launch.

N4HY: USA launch possibilities.

WARC-92

DK1YQ: Contacts with FTZ, Gabriel/Reuter about 23 cm as up and downlink.

DB2OS: Ditto, contacts with ON6UG.

Monetary funding

~ each group covers its own expenses.

~ YT3MV receives support (material, etc.) from AMSAT-NA, AMSAT-DL, etc.

~ G3RUH via AMSAT-UK

Australian Launch Opportunity

Graham Ratcliff, VK5AGR, presented a report about projects by the Australian government. Two rocket launches will be purchased, one with a high risk, the other with a lower risk. AMSAT-VK received an offer to have an Amateur Radio satellite fly along. To date there is no Australian payload, but a lot of ideas. The possibility exists to build a satellite similar to Phase-3D in Australia with AMSAT know-how. We would then have two Phase-3D satellites! Aus$ 2.5 million + 10 million are available. DJ4ZC should cultivate the contacts and present a proposal, possibly visiting Australia to clarify the details personally.

Communication

Telemail is relatively expensive, but currently there are no alternatives. Telefax is very efficient. DB2OS could forward messages to AMSAT-DL from Telemail per telefax. W4PUJ would be interested in a Phase-3D newsletter.

Next Meeting

The next meeting should take place in one year at around the same time. AMSAT-SA and AMSAT-VK would be happy to organize the next meeting. Smaller meetings could take place in the meanwhile. The next opportunity is at the AMSAT-UK Symposium at the University of Surrey in July, 1990. ■

AMSAT APPLICATION NOTES:

This is a new feature beginning with this issue of the Journal. *It is to allow you to share your experiences in equipping yourself for Satellite communications, tracking and telemetry operation. It will contain technical and application notes, that are not quite a full article, and are also not quite in the 'Dear Joe' category. Your contributions, (on a disk, preferably) are welcome and will be appreciated.*

Curing Inter-mod Problems with Satellite Reception at 145.8 to 145.9 MHz

By Wally Bernath, K4UAS
158 Buckingham Road
Winston Salem, N.C. 27104

I live in Winston Salem, North Carolina, within one airline mile of The Baptist Hospital and The Bowman Gray School Of Medicine. My satellite operations, going back to the days of AMSAT-OSCAR 10, began to deteriorate very rapidly as the use of paging systems were installed at the hospital complex. These systems use transmitters operating with 100 to 250 Watts of power at frequencies just above the two meter Amateur band in the range between 158 and 168 MHz. The paging systems operate around the clock, 24 hours a day, 365 days a year, and would cause my mast mounted GaAsFET preamp to break into oscillation anytime my antenna system was aimed in the general direction of the hospital, an arc ranging from -15 degrees to 188 degrees in azimuth. So trying to work stations in Europe, Africa and the Middle East increasingly became almost hopeless.

The signals from these paging systems, now almost constantly active, enter my receiving system, consisting of two KLM 14C's, and when they hit the GaAsFET preamp, it goes wild! The GaAsFET is a Hamtronics LNG 432, completely shielded and mounted in a separate metal box with three sealed coaxial relays that switch it in and out of the two meter antenna system. Gain is advertised to be 18 dB.

While thinking and talking about the problem, I recalled an article that appeared in *Ham Radio Magazine*[1] about a coffee can antenna. That article dealt with the invention of a two meter antenna that was capable of providing relief from inter-mod signals. Some excellent information was also included in the article about the design of coaxial cavity filters.

After doing a little experimenting with coffee can filters, and getting the feel for tuning and adjusting them for proper input and output impedances, I built a single cavity filter in an oblong aluminum case that had just about the optimum ratio of inner and outer diameters for maximum "Q". This filter was tuned to the middle of the Mode B downlink passband, 145.9 MHz. When I installed the filter between the antenna and the GaAsFET preamplifier, I was able to receive satellite signals, without the preamplifier bursting into oscillation. It remained stable except when my antennas were pointed right at the hospital. The next step was to start experimenting with dual coaxial filters in an effort to further attenuate the out of band QRM. I built a few models using aperture coupling, with various bandwidths ranging from 1 to 4 MHz., and carefully adjusting the input and output links for 50 Ohms. The unit I finally selected for use in my installation, shown in Figure 1, has a 1 MHz bandwidth and shows no insertion loss on my test equipment. The input and output connections can be switched with no apparent difference in the performance of the filter. Since I installed this unit between my antennas and the GaAsFET preamplifier, I am no longer troubled with inter-mod from the paging systems.

My test equipment shows that the unit has an attenuation in the 50 to 60 dB range for signals out of the two meter band. The test equipment I used is as follows:

1. Heath Bridge IM-4190 good to 1000 MHz.
2. 30 Watt plug-in dummy load 50 Ohms.
3. IC 211 transceiver as a signal source 8 to 13 Watts (variable).
4. Heathkit GDO as an out of band signal source.
5. Sadelco Receiver tunes 54 to 500 MHz and has a coaxial input and a step attenuator that can measure 60 dB plus a meter that can indicate an additional 20 dB.

These coaxial filters are similar to the desense filters we used back in the AMSAT-OSCAR 8 days. They can easily be constructed for operation in the 435 MHz band and will readily help those hams having desense problems when trying to operate Mode JL. *Termans' Radio Engineering* text and the *ARRL Handbook* are other sources of useful information.

Reference

1. *Ham Radio*, May 1981. ■

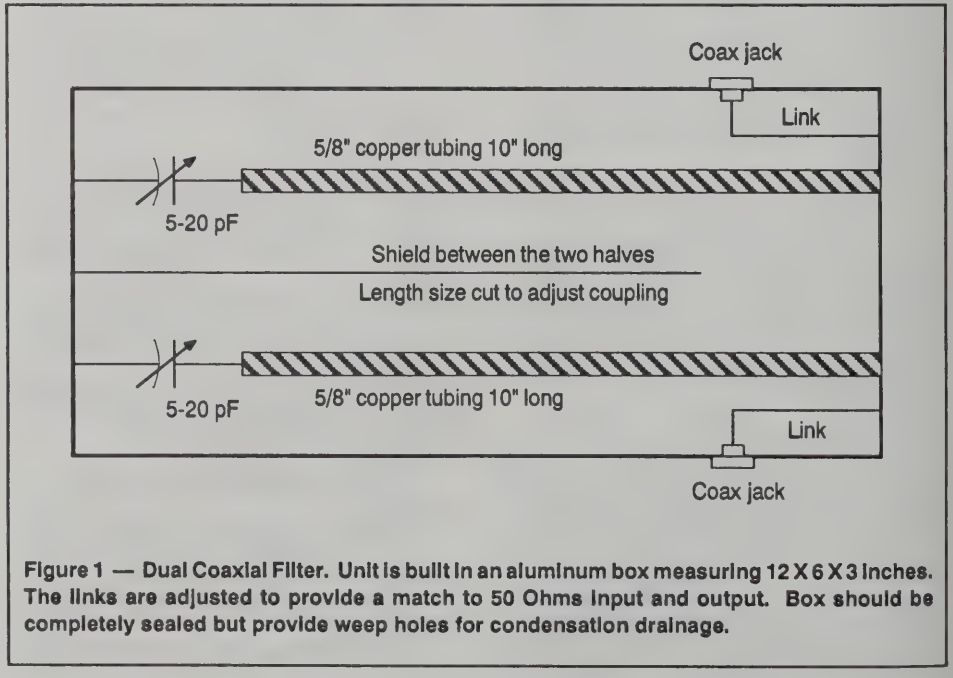


Figure 1 — Dual Coaxial Filter. Unit is built in an aluminum box measuring 12 X 6 X 3 inches. The links are adjusted to provide a match to 50 Ohms input and output. Box should be completely sealed but provide weep holes for condensation drainage.

Crash Landings

Please note the following corrections in the *September Journal.*

Microsat Motion and Stabilization

The vertical (or Y) axis of figures 9, 10, and 14 should be labeled "Amps" not "mA". Also, the labels N and S on the magnet in Figure 1 are reversed. The description in the text is correct. The label on the end of the magnet at the +Z surface might more clearly be labeled "South Pole Seeking" and the opposite end "North Pole Seeking".

BBS Phone Number

W6GO's DX BBS telephone number was printed incorrectly in his letter, the correct telephone number is (916) 992-0923. Jay suggests that people connect to it and read Bulletin 10 for further information on downloading SAREX related files.

Telemetry Reception with the PK-232

When counting modems, we should have published the following sentence at the end of Page 4:

"Installing the modem disconnect board is easier and leaves you with the PK-232's external modem disconnect port free so you can now have two external modems. Both of mine are used so I now need **three!**"

Orbital Estimation for Low Earth Orbit Satellites

Several alert readers, including NS4S, KC2ZF and Max White of AMSAT-UK, have pointed out an error in this article.

The formula given for correcting RAAN when the epoch is changed takes into account only the Earth's revolution about the sun but fails to consider its revolution on its axis; hence, it is correct only for epoch changes of an integral number of days. The correct general formula, supplied by NS4S, is that the RAAN correction (in degrees) for a given epoch change is given by (360.9856475 * t) modulo 360, where t is the epoch change in days and fractions of one day. In the example given in the article, where the epoch increases by two minutes, the RAAN correction should be 0.501369 degrees, rather than 0.001369 degrees as stated.

Thanks to Rich, Ed and Max for bringing this to my attention. — *Ray Soifer, W2RS* ■

OSCAR-13 NEWS

Command Stations performed magnetorquing procedures near perigee of orbits on October 15-17. The new transponder schedule is as follows:

Mode-B:	MA 000 to 095
Mode-JL:	MA 095 to 125
Mode-LS:	MA 125 to 130
Mode-S:	MA 130 to 135
Mode-BS:	MA 135 to 140
Mode-B:	MA 140 to 256
Omnis:	MA 220 to 040

This schedule is expected to continue through 26-Dec-90. The spacecraft attitude is BLON = 180 and BLAT = 0. ■

Need information on tracking software? Call AMSAT Hq. at (301) 589-6062 or write to AMSAT, 850 Sligo Ave., Silver Spring, MD 20910.

MULTIFAX SOFTWARE - records, displays, manipulates, saves and prints weather facsimile pictures and charts from satellite and ground-based transmissions, and is designed for use with IBM PC's, XT's, AT's and clones. **FOUR PROGRAMS** are available, MF2.3 for CGA, 320X200 pixels, using 2 or 4 colors on an RGB monitor, MF3.4 for EGA, 640X350 pixels, using 2, 4, 8 or 16 colors from 64 using EGA monitor, MF4.0 for VGA, 640X480 pixels, using 2, 4, 8 or 16 colors from 262,144, and provides gray-scale or color viewing with a VGA monitor, MF5.0 for VGA, that can automatically save to either RAM drive or hard disk, along with an enhanced syncing feature for APT. **HIGHEST DETAIL** can be displayed from the 1280 samples made for each FAX line by zooming in on any selected area. All programs use the game port for data input and can be printed on an IBM Graphics, IBM Proprinter, or equivalent printer.

MULTIFAX is just **$49** ($20 for upgrades)

"PRECISION "AM/FM WEFAX DEMOD

This new WEFAX demod has been designed with quality and picture detail in mind, and can be used to provide superior results with NOAA and METEOR polar orbiting APT facsimile, GOES Geostationary facsimile, HF weather charts and gray-scale pictures, and HF News Service facsimile picture broadcasts. The switchable tuning display board makes this "Precision" demod easy to use. Available in kit form, with all components, main and display PC boards and documentation. This kit requires a cabinet, power supply and connecting cables. PC boards are available, as is a completed, aligned kit.

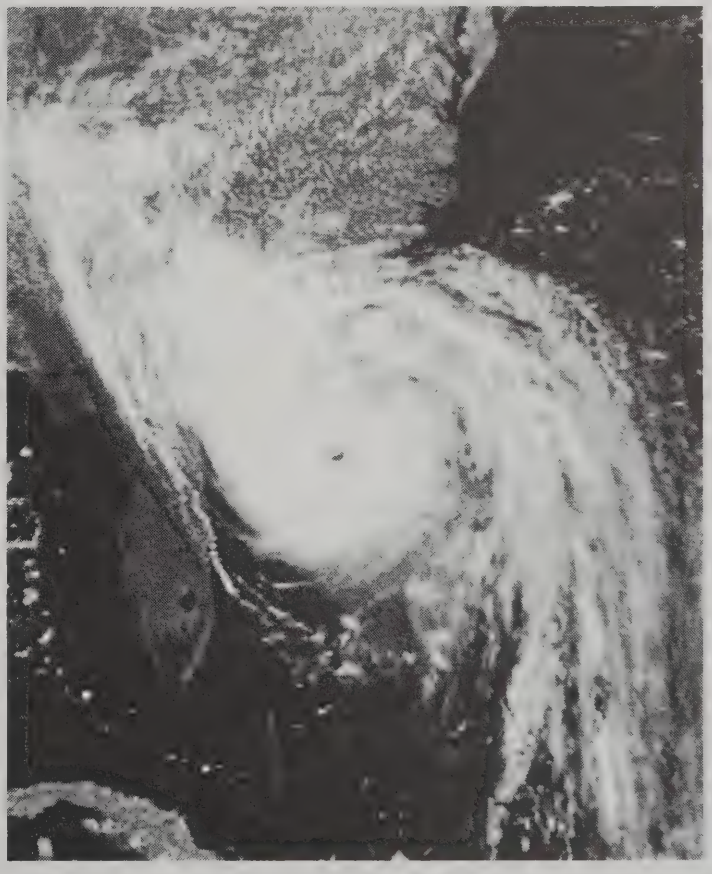
AM/FM Demod kit is just **$129** ($29 for boards only)

Write or call for information:

David E. Schwittek, NW2T

1659 Waterford Road, Walworth, NY 14568

(315)986-2719



Amateur Satellite Frequency Guide

Produced by AMSAT-NA

In return for a donation of $25 AMSAT will send you, as a holiday present, a similar frequency chart in laminated plastic, ideal for use in your station or as a gift for someone you are introducing to the fascinating world of the Amateur satellites.

AMSAT OSCAR 10

Summary: Mode B: 70 cm up; 2 meters down
Mode L: 24 cm up; 70 cm down
Beacons: Mode B: General Beacon 145.810 MHz; Engineering Beacon 145.987 MHz
Mode B: 435.030-435.180 up yields 145.825-145.975 MHz down (inverting)

Uplink	Downlink	
	145.987 MHz	Engineering Beacon
435.030	145.975	Passband limit
435.045	145.960	General use limit
435.050	145.955	
435.060	145.945	
435.070	145.935	
435.080	145.925	
435.090	145.915	
435.100	145.905	
435.105	145.900	Passband center
435.110	145.895	
435.120	145.885	
435.130	145.875	
435.140	145.865	
435.150	145.855	
435.160	145.845	General use limit
435.180	145.825	Passband limit
	145.810	General Beacon

UoSAT OSCAR 11

Summary: Downlinks on 2 meters, 70 cm and 13 cm; no uplinks since this is primarily an educational and research spacecraft.

VHF downlink: 145.825 MHz
UHF downlink: 435.025 MHz
UHF downlink: 2401.5 MHz

AMSAT OSCAR 13

Summary:
Mode B: 70 cm up; 2 meters down
Mode JL: 24 cm and 2 meters up; 70 cm down
Mode S: 70 cm up; 13 cm down
RUDAK: 24 cm up; 70 cm down
Beacons: Mode B: General Beacon 145.812; Engineering Beacon 145.985 MHz
Mode JL: General Beacon 435.651; EB/RUDAK Downlink: 435.677 MHz
Mode S: Beacon: 2400.325 MHz

Mode B:

Uplink	Downlink	
	145.985 MHz	Engineering Beacon
435.423	145.975	Passband limit
435.433	145.965	
435.443	145.955	
435.453	145.945	
435.463	145.935	
435.473	145.925	
435.483	145.915	
435.493	145.905	
435.503	145.895	
435.508	145.890	Passband center
435.513	145.885	
435.523	145.875	
435.533	145.865	
435.543	145.855	
435.553	145.845	
435.563	145.835	
435.573	145.825	Passband limit
	145.812	General Beacon

Mode JL:

L Uplink	J Uplink	Downlink	
1269.351		436.005	Passband limit
1269.361		435.995	
1269.366	144.423	435.990	J Sub-Band limit
1269.376	144.433	435.980	
1269.386	144.443	435.970	
1269.396	144.453	435.960	
1269.406	144.463	435.950	
1269.416	144.473	435.940	J Sub-Band limit
1269.421		435.935	
1269.431		435.925	
1269.441		435.915	
1269.451		435.905	
1269.461		435.895	
1269.471		435.885	
1269.481		435.875	
1269.491		435.865	
1269.496		435.860	Passband Center
1269.501		435.855	
1269.511		435.845	
1269.521		435.835	
1269.531		435.825	
1269.541		435.815	
1269.551		435.805	
1269.561		435.795	
1269.571		435.785	
1269.581		435.775	
1269.591		435.765	
1269.601		435.755	
1269.611		435.745	
1269.621		435.735	
1269.631		435.725	
1269.641		435.715	

Mode S:

Uplink	Downlink	
435.603	2400.711MHz	Passband limit
435.607	2400.715	
435.612	2400.720	
435.617	2400.725	
435.621	2400.729	Passband center
435.622	2400.730	
435.627	2400.735	
435.632	2400.740	
435.637	2400.745	
435.639	2400.747	Passband limit
	2400.664	Beacon

RUDAK:

Uplink	Downlink	
1269.710	435.677 MHz	Single channel

1269.710 RUDAK Uplink
435.677 Eng. Beacon/RUDAK Downlink

435.651 General Beacon

UoSAT OSCAR 14

Uplink 145.975 MHz 9600 bps FSK (FM)

Downlink 435.070 MHz 9600 bps FSK (FM)

435.070 MHz 1200 bps AFSK (NBFM)

UoSAT OSCAR 15

Downlink 435.120 MHz 9600 bps FSK (FM) AX.25

435.120 MHz 1200 bps AFSK (NBFM) Standard Bell 202

Note: CCD camera, 760x960 km view.

AMSAT OSCAR 16

Uplink 145.900, 145.920, 145.940, 145.960 MHz AFSK (FM) 1200 bps AX.25 Manchester

Nominal PSK
Downlink 437.02625 MHz 1200 bps BPSK (SSB) AX.25

Raised Cosine
Downlink 437.05130 MHz 1200 bps BPSK (SSB) AX.25

S-Band Downlink 2401.1428 MHz 1200 bps BPSK (SSB) AX.25

DOVE OSCAR 17

FM Downlink #1

145.82516 MHz 1200 bps AFSK (FM) AX.25 or digital voice messages.

FM Downlink #2

145.82438 MHz 1200 bps AFSK (FM) AX.25 or digital voice messages.

Standard Packet TNC for either signal.

S-Band Downlink

2401.2205 MHz 1200 bps BPSK 1 Watt

WEBER OSCAR 18

Nominal PSK
Downlink 437.07510 MHz 1200 bps BPSK (SSB) AX.25

Raised Cosine
Downlink 437.10200 MHz 1200 bps BPSK (SSB) AX.25

ATV NTSC Uplink

1265.000 MHz AM-TV

Note: CCD camera, 350 x 350 km view.

LUSAT OSCAR 19

Uplink 145.840, 145.860, 145.880, 145.900 MHz AFSK (FM) 1200 bps AX.25 Manchester

Nominal PSK
Downlink 437.15355 MHz 1200 bps BPSK (SSB) AX.25

Raised Cosine
Beacon 437.12580 MHz 1200 bps BPSK (SSB) AX 25

CW
Beacon 437.125 MHz 12 wpm CW Telemetry, 750 mW

FUJI OSCAR 20

Mode JA:

Uplink	Downlink	
145.900	435.900 MHz	Passband limit
145.910	435.890	
145.920	435.880	
145.930	435.870	
145.940	435.860	
145.950	435.850	Passband center
145.960	435.840	
145.970	435.830	
145.980	435.820	
145.990	435.810	
146.000	435.800	Passband limit
	435.795	Beacon

JD Uplink 145.850, 145.890, 145.910 MHz AFSK (FM) 1200 bps AX.25 Manchester

JD Downlink 435.910 MHz 1200 bps BPSK (SSB)

Radio Sputnik 10

Summary:
Mode K: 2 meters up and 10 meters down.
Mode K: 15 meters up and 10 meters down.
Mode T: 15 meters up and 2 meters down.
Mode KT: 15 meters up, 10 and 2 meters down.
Mode KA: 15 and 2 meters up, 10 meters down.

Beacons can carry telemetry or ROBOT downlink.

Mode A: 145.860-145.900 MHz up yields 29.360-29.400 MHz down

Uplink	Downlink	
	29.357 MHz	Beacon
145.860	29.360	Passband limit
145.870	29.370	
145.880	29.380	Passband center
145.890	29.390	
145.900	29.400	Passband limit
	29.403	Beacon

Robot A:

145.820 29.357 or 29.403 MHz

Mode K: 21.160-21.200 MHz up yields 29.360-29.400 MHz down

	29.357 MHz	Beacon
21.160	29.360	Passband limit
21.170	29.370	
21.180	29.380	Passband center
21.190	29.390	
21.200	29.400	Passband limit
	29.403	Beacon

Robot K:

21.120 29.357 or 29.403 MHz

Mode T: 21.160-21.200 up yields 145.860-145.900 MHz down

	145.857 MHz	Beacon
21.160	145.860	Passband limit
21.170	145.870	
21.180	145.880	Passband center
21.190	145.890	
21.200	145.900	Passband limit
	145.903	Beacon

Robot T:

21.120 145.857 or 145.903 MHz

Mode KT: 21.160-21.200 up yields 29.360-29.400 and 145.860-145.900 MHz down

KT Uplink	K Downlink	T Downlink	
	29.357	145.857MHz	Beacon
21.160	29.360	145.860	Passband limit
21.170	29.370	145.870	
21.180	29.380	145.880	Passband center
21.190	29.390	145.890	
21.200	29.400	145.900	Passband limit
	29.403	145.903	Beacon

Mode KA: 21.160-21.200 and 145.860-145.900 up yields 29.360-29.400 MHz down

K Uplink	A Uplink	KA Downlink	
		29.357MHz	Beacon
21.160	145.860	29.360	Passband limit
21.170	145.870	29.370	
21.180	145.880	29.380	Passband center
21.190	145.890	29.390	
21.200	145.900	29.400	Passband limit
		29.403	Beacon

Radio Sputnik 11

Summary:
Mode A: 2 meters up and 10 meters down.
Mode K: 15 meters up and 10 meters down.
Mode T: 15 meters up and 2 meters down.
Mode KT: 15 meters up, 10 and 2 meters down.
Mode KA: 15 and 2 meters up and 10 meters down.

Beacons can carry telemetry or ROBOT downlink

Mode A: 145.910-145.950 MHz up yields 29.410-29.450 MHz down

Uplink	Downlink	
	29.407 MHz	Beacon
145.910	29.410	Passband limit
145.920	29.420	
145.930	29.430	Passband center
145.940	29.440	
145.950	29.450	Passband limit
	29.453	Beacon

Robot A:

145.830 29.407 or 29.453 MHz

Mode K: 21.210-21.250 up yields 29.410-29.450 MHz down

	29.403 MHz	Beacon
21.210	29.410	Passband limit
21.220	29.420	
21.230	29.430	Passband center
21.240	29.440	
21.250	29.450	Passband limit
	29.453	Beacon

Robot K:

21.130 29.403 or 29.453 MHz

Mode T: 21.210-21.250 up yields 145.910-145.950 MHz down

	145.907 MHz	Beacon
21.210	145.910	Passband limit
21.220	145.920	
21.230	145.930	Passband center
21.240	145.940	
21.250	145.950	Passband limit
	145.953	Beacon

Robot T:

21.130 145.907 or 145.953 MHz

Mode KT: 21.210-21.250 up yields 29.410-29.450 and 145.910-145.950 MHz down

KT Uplink	K Downlink	T Downlink	
	29.407	145.907MHz	Beacon
21.210	29.410	145.910	Passband limit
21.220	29.420	145.920	
21.230	29.430	145.930	Passband center
21.240	29.440	145.940	
21.250	29.450	145.950	Passband limit
	29.453	145.953	Beacon

Mode KA: 21.210-21.250 and 145.910-145.950 up yields 29.410-29.450 MHz down

K Uplink	A Uplink	KA Downlink	
		29.407MHz	Beacon
21.210	145.910	29.410	Passband limit
21.220	145.920	29.420	
21.230	145.930	29.430	Passband center
21.240	145.940	29.440	
21.250	145.950	29.450	Passband limit
		29.453	Beacon

Higher Orbits

Three friends of the Satellite Program pass on.

Valery Kondratko, UV3DQE

A LIFE LIKE A FLIGHT

Valery Kondratko, cosmonaut in training and co-author of 'CQ EARTH, This is Mir Calling', published in the May 1990 issue of the *AMSAT Journal*, was killed in an aircraft accident on the 13th of April 1990 near Uelen in the Chukostkiy Peninsula when an AN-2 aircraft carrying members of the international polar expedition "Big Ring" as well as thirty sleigh dogs, crashed soon after takeoff. Valery was a guy who wanted to be a cosmonaut in space, and almost become one.

In a newspaper clipping from the *Anchorage Daily News*, Don Hunter described details of the crash. "On board the one engine biplane, slightly larger than a Twin Otter, were an American, two Russian dog handlers, a guide, and two pilots. We sat on the sleighs and tried to keep the dogs calm", said Sue Stenaker. "When I realized, that we where falling. I lay down flat on the sleigh and held on to it tightly. The guy that died had nothing to brace himself on. He flew out to the right and landed in front. The pilots suffered the least of all the people in the plane."

Two hundred people from the settlement who had come to see the plane take off, ran through the snow to the crash site. As they arrived, several terrified dogs jumped from the plane wreckage and ran off barking into the tundra. The Russian dog handler, everyone called Valery, showed no signs of life. He had a large gash on his head which did not bleed and there was no sign of a pulse. CPR was performed on the spot without any results, so someone drove Valery to Uelen in a snowmobile, but the local physicians were also unable to resuscitate him.

UA3DQE

Valery, was an engineer at the Soviet Space Flight Control Center. The day before this, his final flight, Valery had crossed 300 kilometers of Chukotksiy tundra with the expedition. Before that, as of 1982, he had taken part in all of the polar expeditions organized by "Komsomolskaya Pravda". He was a member of the Ski Trek expedition which reached the Pole on skis at night a year or so ago. He was a base radio operator for the recent Soviet-Canadian Trans-Arctic expedition.

Whereas for most people, even taking part in these trans-arctic expeditions would be enough in itself, Valery just considered them as a means of preparing himself for a different, more difficult challenge. While all of his friends knew of Valery's dream of becoming a cosmonaut, most of them did not realize how much effort he had put into achieving that goal.

From the beginning, he had almost no chance of going into space. Nearsightedness for a candidate to the cosmonaut corps is a worse obstacle than the Earth's gravitation field. In 1975, after serving in the military, Valery came to Moscow to find specialists capable of repairing his eyesight. He understood, that potentially it could take a long time. Where to put his time to a best possible use? Behind a student's desk at the Moscow Aviation Institute (MAI) of course.

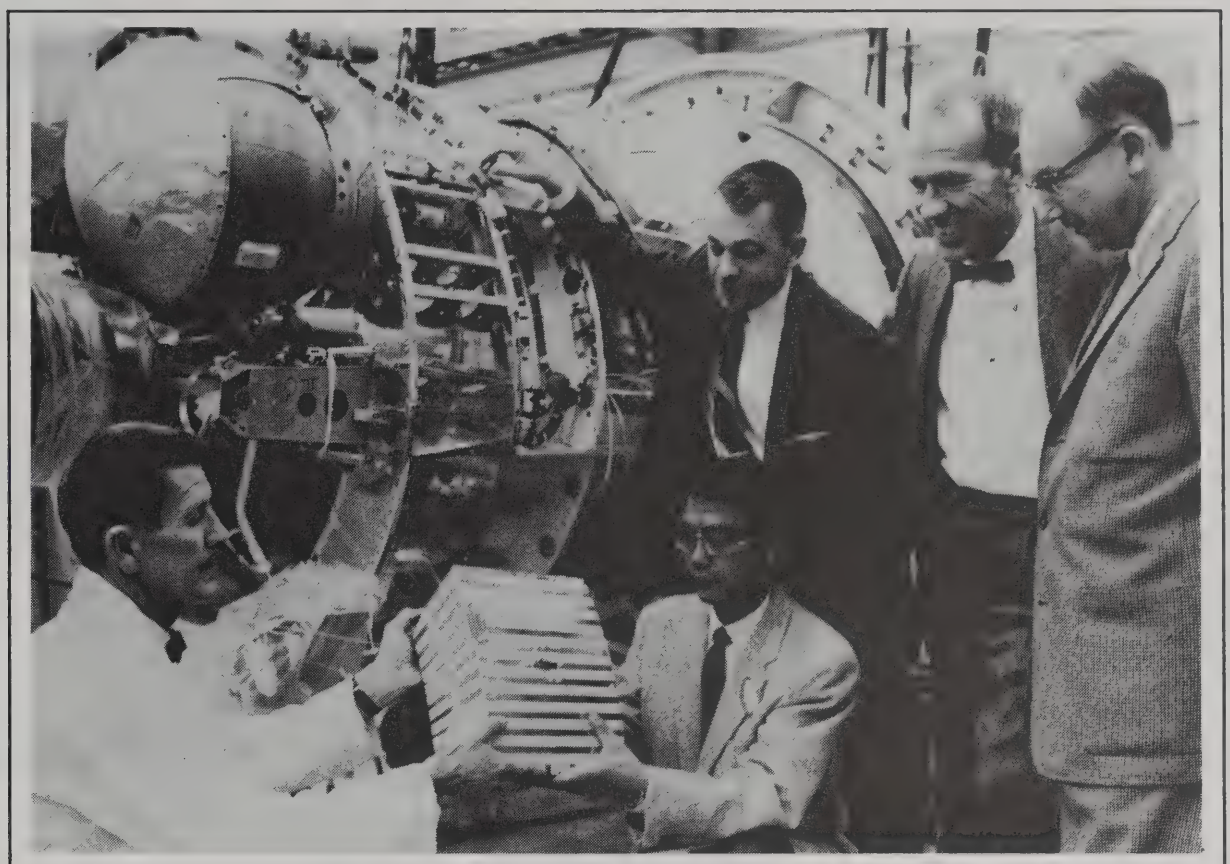
After he was accepted as a student at MAI, he began a methodical search from one eye clinic to another: who would help? The Fyedorov clinic was doing experimental surgery, but the waiting list, Valery was told, was two years. In reality it took four. Only during his last, fifth, year at MAI, was he was admitted for surgery and left the clinic with a hundred percent vision.

That was when, after hearing about the preparations for the polar expeditions under the banner of the "Komsomolskaya Pravda" newspaper, Valery went to the expedition chief, Dmitryi Shparo, and said "Take me".

"Have you ever traveled with a heavy backpack" ? "No". "Have you ever slept on the snow"? "No". "Have you ever traveled on skis"? "No". "And where are they assigning you to work after finishing MAI"? "Kiev, I think".

Shparo shrugged, "What would we need you for" ?[1]

During his final winter vacation at the MAI Valery went on a trip to a tourist camp



Standing (l to r): Chuck Towns, K6LFH, Fred Hicks, W6EJU, and Nick Marshall, W6OLO. The satellite is OSCAR 11.

in Karelia at his own expense. There he loaded up a very heavy backpack and left for a seven day camping trip. That was the first step. Upon his return, Valery went to Victor Blagov — already a famous figure at that time — vice chief of flight operations in the Flight Control Center (abbreviated in Russian as CUP, Centralnoe Upravlenie Poleotom), near Moscow. Valery asked for employment. That was step two. He put it straight, "I would like to be a cosmonaut." Blagov looked at the visitor appraisingly, and replied, "Well, what do you know. I can use people like you."

Shparo was quite surprised when a year later, Valery showed up in the gym of the Pravda publishers, where for seventeen years in a row the training of our polar expedition team took place. Soon after that, he was taken along on a training expedition over the ice covering the Laptev Sea. Later Valery told me," I was so cold that at night I'd be woken up by the chattering of my own teeth." He suffered from incredible tiredness, sometimes he fell asleep while walking, but he never let on: in space, he felt it must be even worse.

Nine years flew by. He was long accepted as a team member at the CUP, winning recognition by his high professionalism, willingness and devotion. He covered thousand of kilometers on skis over drifting ice and tundra. Was space any closer now? It depended on one's outlook. He went through one medical commission's exam after another. It seemed his vision problems did not bother anyone now, but they found some other catch. Valery needed another operation. That problem was solved. Then something else was wrong again. Again he was in the hands of physicians, again he trained, again he tried to "toughen up" using his own methods. Then he was back for another medical commission... Finally, everything seemed fine. He was supposed to be able to fly. He was scheduled to.

Three years ago we participated in a summer training expedition together in the mountains of Tian Shan. After climbing the Severe pass up an almost vertical mountain wall (it was over five kilometers high) we stopped on a snowy plateau to catch our breath. I was completely happy to see all the surrounding peaks left beneath our feet. That, it seemed, was my limit. Valery however, looked up and sighed, "Space is so close."

He died so close to Earth, carried up just a little way by that old bi-plane. What a waste! The Universe was within his reach. He would have come through!

For those who knew him well, there is now one cosmonaut less. We miss him. — *V. Snegirev* (translated by Alla Lake)

[1] Translator's note : Dmitryi Shparo was probably being sarcastic, as Kiev is in the Ukraine and has a mild climate.

Chuck Towns, K6LFH

The Amateur Radio Satellite Program lost one of our early pioneers and strongest supporters. Chuck Towns, K6LFH, passed away on September 28th at his home in Los Gatos (CA). A memorial service was held on October 5th in Saratoga (CA).

Chuck was one of the founding members of Project OSCAR, and continued to promote the amateur satellite program until his passing. Many of us in the San Francisco Bay Area became active on OSCAR because of the support and help Chuck provided. In addition to his activities in the satellite program, Chuck was active in emergency communications and the Sister City program. — *Ross, WB6GFJ*

Hayden Evans, K2BZT

I regret to have to report the death on September 24 of Hayden Evans, K2BZT. Hayden, an early and active operator on AMSAT-OSCAR 6 and subsequent satellites, was a retired executive of AT&T Bell Laboratories. As a member of the ARRL DX Advisory Committee in the 1970s, Hayden was the originator of the Satellite DXCC award. He was also a charter member and past president of the North Jersey DX Association. No further details are available. (Info via NJDXA DX packet cluster system) — *Ray, W2RS* ■

AMSAT News

Board Election Results

Here are the results of the election. The ballots were tabulated at the AMSAT office. They are as follows:

715 ballots were cast and counted:

Name	*Votes*
Tom Clark	491
Doug Loughmiller	351
John Champa	256
Junior de Castro	226
Joe Kasser	220
Courtney Duncan	209
Ray Soifer	204
Jack Crabtree	141

Tom Clark, Doug Loughmiller and John Champa are elected to the Board, Junior de Castro and Joe Kasser are elected as alternates. ■

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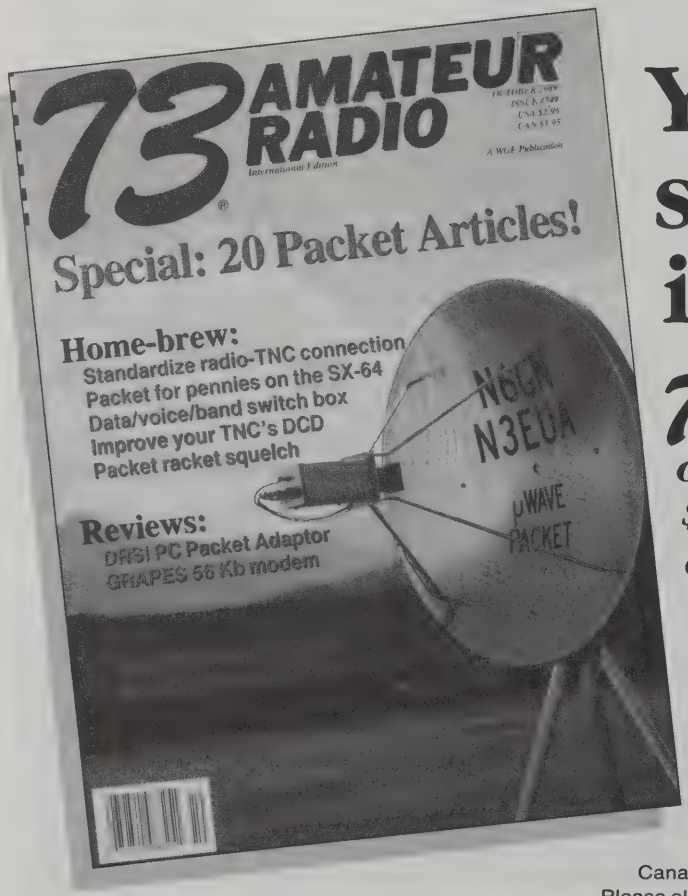

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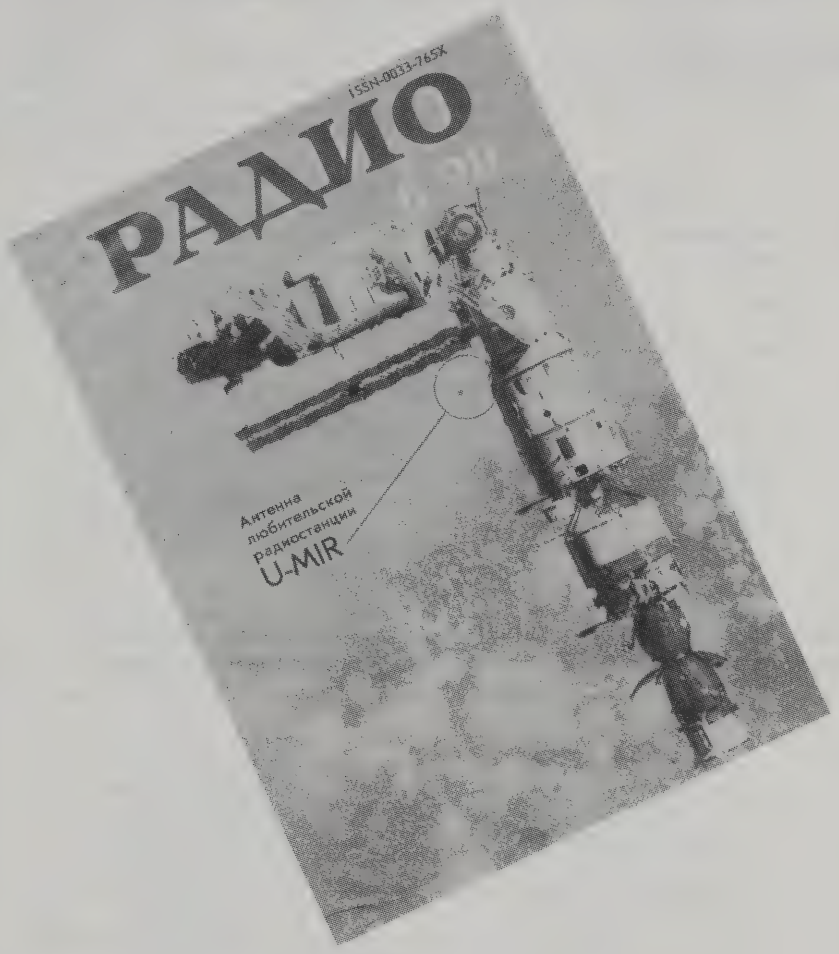
Austrian Hams to fly on Mir



Cover of Radio Magazine August 1990 showing 2 meter antenna on Mir.

The Austrian Radio Amateur monthly publication *QSP* for September 1990 brought exciting news to the satellite community. A proposal has been made for an Austrian Amateur Radio Experiment AREM to fly on the Soviet Mir space station. In the first phase, (scheduled for January 1991) beside the normal 2 meter voice transmissions an automatic beacon transmitter is planned to be operational. This beacon will broadcast information in packet radio and in synthesized voice.

To further ham radio and especially to use satellite transmissions in education, a special program will be prepared for use by school teachers who hold an Amateur license. Interested parties please contact OE7FTJ (address below), or the OeVSV (Theresiengasse 11, A-1180 Vienna, Austria).

The flight equipment will consist of a laptop computer connected to both a TNC and a voice synthesizer, which in turn feed the 144 MHz transceiver. An external 2 meter antenna attached to MIR will be used for the transmissions. Power will be taken from the MIR supply, 1 amp max. at 28.5V. A DC to DC converter will be used to supply the required 5V and 12V.

The TNC will use 1200 bps AFSK with the usual AX.25, so that all earthbound stations can receive the transmissions with their normal packet equipment.

The voice synthesizer will use delta modulation. The advantage of this modulation: the digitized speech uses relatively few bytes, and can be transmitted via the modulator. Messages with greetings and general information will by transmitted in English, Russian, and German. Data transmissions will alternate with voice. The cosmonauts (and two Austrian cosmonauts are currently in training at Star City — one will fly) can, if time permits, switch off the beacon, grab the mike for a QSO.

The equipment will stay on board MIR and will be available for hams and school use.

Phase two (scheduled for November 1992) envisages an uplink and the use of simple BBS software.

For further information please contact:
Wolf Hoeller, OE7FTJ
Amraserstrasse 19
A-6020 Innsbruck
Austria

Tel.: +43-512-44-158 (home)

Note by OE3ACC: If you want to call Wolf, PLEASE do so at "human" times! His XYL has just put a loud and vocal transceiver "online"! Neither she, nor Wolf want to "trigger" this charming transceiver at 03:00 hours! In Austria we are now on UTC+2 (soon comes winter time with UTC+1).

I will gladly QSP any messages for Wolf and will post further news as they become available.— *Alexander,* OE3ACC CIS: 72047,1712. ■

The AMSAT Proceedings from the Symposium Now Available

If you were unable to attend the 1990 AMSAT Symposium/Annual Meeting, perhaps you'd be interested in the *Symposium Proceedings*, an 80-page book with articles written by the Speakers on their topic of presentation. It's nearly three times the size of a typical issue of the *AMSAT Journal*, and without advertising! Essentially the Table of Contents looks similar to the listing of topics given on page 29 of *The AMSAT Journal* (for September 1990). The range of presentations is from very technical to very basic and informational. AMSAT Headquarters has a limited quantity of these books available for a donation of $20 each, which helps support your Amateur Radio Satellite Program. In addition, if you don't already have a copy of last year's *Symposium Proceedings* as they appeared in AMSAT's *Journal* for November, 1989, Martha will include one free. That's about 100 pages of information on the Satellite Program! Write to AMSAT, 850 Sligo Ave., Silver Spring, MD 20910 or call 301-589-6062.

An Efficient Method for Calculating Average Daily Access Time as a Function of Ground Station Latitude for a Satellite Orbit

By Martin Davidoff, K2UBC
13803 Manor Glen Rd.
Baldwin, MD 21013

Abstract

This article describes an efficient method for calculating average daily access time as a function of ground station latitude for a satellite orbit. The method is illustrated by two BASIC programs — one for circular orbits and one for elliptical orbits. Results for several orbits of interest are presented.

Introduction

If, for a satellite orbit, the distribution of values for the longitude at ascending node is random then average daily access time is completely characterized by:

For circular orbits — (1) inclination, (2) period, and (3) ground station latitude;

For elliptical orbits — (1) inclination, (2) period, (3) eccentricity, (4) argument of perigee and (5) ground station latitude.

Most spacecraft orbits satisfy this criteria. One important exception is geostationary orbits.

Method

To calculate average daily access time we divide a single orbit (perigee to perigee for elliptical orbits, ascending node to ascending node for circular orbits) into a convenient number of discrete segments. Segments based on equal intervals in true anomaly work well. For each segment we calculate the time duration (ti), and the

Satellite Orbit Geometry

(Circular Orbits)

	Height (kms)	Inclination (deg.)	Period (min.)
DOVE	804	98.7	100.8
MIR	395	51.6	92.3
STS-35	350	28.5	91.4
FO-12	1490	50.0	115.7
RS-8	1690	83.0	119.1
RS-10/11	990	82.9	104.9

Table 1 — Orbital data used to prepare Figure 1.

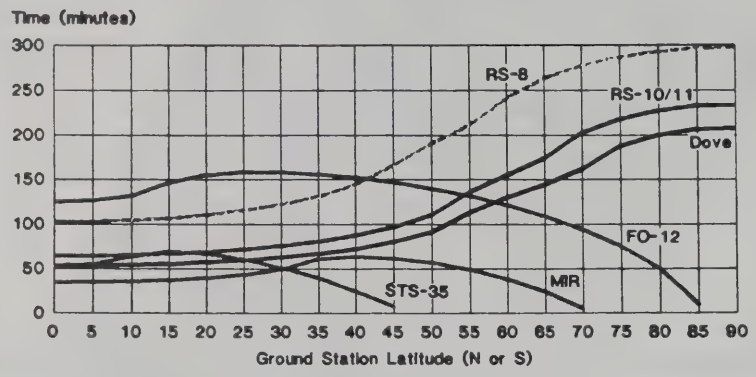


Figure 1 — Average Daily Access time for several circular orbits.

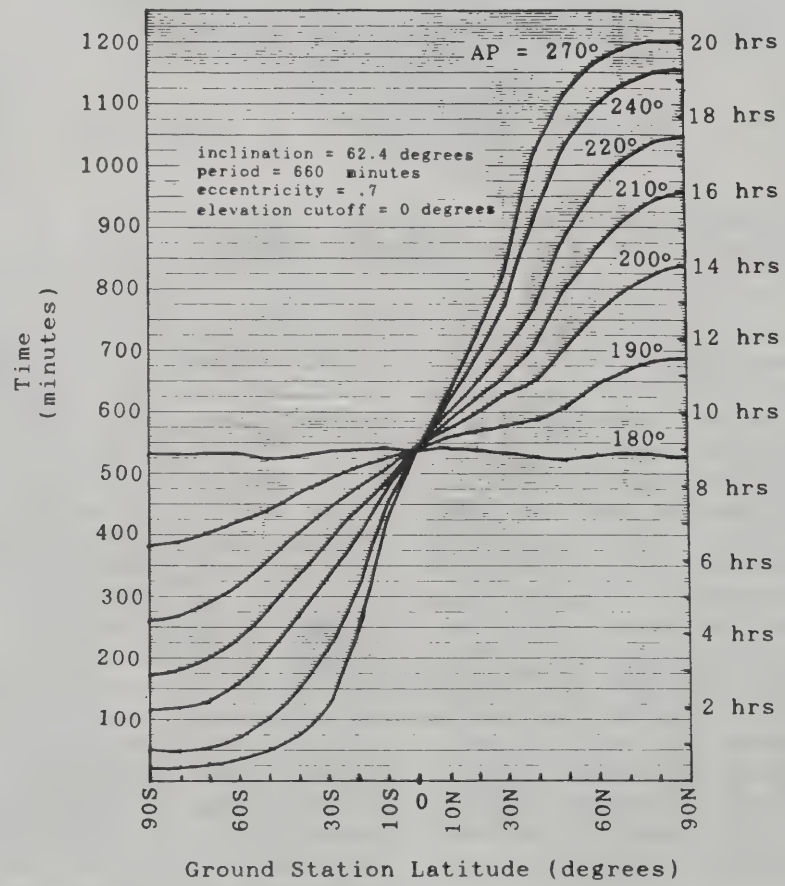


Figure 2 — Average Daily Access time for possible Phase 3D orbit.

```
10  PROGNAME$ = "ADATCIRC — Average Daily Access Time"
20  VERSION$ =       Circular  Orbits   Sept 26, 1990"
30   '
40 'Satellite Identification, Etc.
50    SAT$ = "DOVE"   ' **
60    INCLINATION = 98.7     ' degrees  **
70    PERIOD = 100.8         ' minutes  **
80    ELEVATION = 0 'Satellite above this angle is in range  **
90    NSEG = 100             'Number of segments per orbit    **
100      '
110 'CONSTANTS, CONVERSION FACTORS, FUNCTIONS, ETC.
120      PI = 3.141593
130      RTOD = 180/PI     'conversion factor, radians -> degrees
140      DTOR = PI/180     'conversion factor, degrees -> radians
150      RE = 6371  'Mean radius of earth
160      DEF FNARCSIN(Z) = ATN(Z/SQR(1-Z*Z))
170      DEF FNARCCOS(Z) = PI/2 - ATN(Z/SQR(1-Z*Z))
190      ELEV = ELEVATION*DTOR
200      SININCLIN = SIN(INCLINATION*DTOR)
205      HEIGHT = 331.25 * PERIOD^(2/3) - RE
210      'Calculate Beta (Surface distance in radians between ground
220             ' station and elevation circle)
230          BETA = FNARCCOS(COS(ELEV)*RE/(RE+HEIGHT)) - ELEV
240          COSBETA = COS(BETA)
250             '
260   'Initialize parameters
270      FOR I = 0 TO 9  : TOTTIME(I) = 0  : NEXT I
280    '
290   FOR SEG = 1 TO NSEG 'Loop through one orbit (perigee to perigee) <<<
300     'Calculate polar angle (ascending node to midpoint of segment)   ^
310          THETA = PI*(2*SEG - 1)/NSEG       '           ^
320     'Calculate latitude of SSP at midpoint of segment (SSPLAT)        ^
330          SSPLAT = FNARCSIN(SIN(THETA)*SININCLIN)          '          ^
340    '          ^
350     FOR K = 0 TO 9     'Loop through ground station latitudes   <<<<  ^
360       GSLATITUDE = K*10    ' ground station latitude in degrees     ^  ^
370       GSLAT = GSLATITUDE*DTOR      '         ^  ^
380       IF ABS(GSLATITUDE) > 89.9 THEN GSLAT = GSLAT*.9999 '          ^  ^
390       GOSUB 500  ' calculate probability factor (P) for segment    ^  ^
400       TOTTIME(K) = TOTTIME(K) + P*PERIOD/NSEG                '      ^  ^
410     NEXT K     '   >>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>^  ^
420    '           ^
430   NEXT SEG     '   >>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>^
440    '
450   GOSUB 590 ' Subroutine to print heading
460   FOR J = 0 TO 9  : PRINT J*10 , TOTTIME(J)*1440/PERIOD : NEXT J
470    '
480 END    'ADATCIRC  M. Davidoff, K2UBC
490   '
500 'Subroutine to find probability factor for each segment
510       ' logic only covers ground station latitudes >= 0
520     IF SSPLAT > (GSLAT+BETA) THEN P = 0 : GOTO 570
530     IF SSPLAT < (GSLAT-BETA) THEN P = 0 : GOTO 570
540     IF SSPLAT > PI - (GSLAT+BETA) THEN P = 1 : GOTO 570
550  DL =FNARCCOS((COSBETA-SIN(GSLAT)*SIN(SSPLAT)) / (COS(GSLAT)*COS(SSPLAT)))
560     P = DL/PI   ' Probability of satellite being in range during segment
570 RETURN
580         '
590 'Subroutine to print heading
600     PRINT : PRINT PROGNAME$ : PRINT VERSION$ : PRINT
610     PRINT SAT$
620     PRINT "      inclination ="; INCLINATION; "degrees"
630     PRINT "      period ="; PERIOD; " minutes"
640     PRINT "      elevation cutoff ="; ELEVATION; "degrees"
650     PRINT "      number of segments used ="; NSEG
660     PRINT : PRINT
670     PRINT " Ground         Average      "
680     PRINT " Station        Daily Access "
690     PRINT " (deg N)        Time (min.)  "
700     PRINT
710     RETURN
```

Table 2 — Average daily access time program (MS BASIC) for circular orbits.

probability factor (Pi), that the spacecraft will be in range. Summing the product (Pi)(ti) over an orbit and then multiplying by the mean motion yields the average daily access time for the specific orbit and ground station being considered.

The probability factor for each segment

AMSAT Headquarters has the Satellite Operating Software you need. For a complete list, see the *AMSAT Journal*, July, 1990, page 14.

A Beginners Guide to OSCAR 13, by Keith Berglund, WB5ZDP, is a step-by-step guide to getting started on OSCAR 13. $7 in the U.S., $8 in Canada and Mexico, $10 elsewhere.

The Satellite Experimenter's Handbook, by Dr. Marty Davidoff, K2UBC, is the finest book written for the Radio Amateur. $10 in the U.S., $15 elsewhere.

Satellite Anthology is the best of recent *QST* articles on Amateur Satellite Operation and hardware. $8 in the U.S., $9 Canada, $10 elsewhere.

Call AMSAT Hq. at (301) 589-6062 or write to AMSAT, 850 Sligo Ave., Silver Spring, MD 20910.

```
10  PROGNAME$ = "ADATEL — Average Daily Access Time"
20  VERSION$ =  "     Eliptical Orbits   Sept 25, 1990"
30   '
40 'Satellite Identification, Etc.
50    SAT$ = "P3-D"   ' **
60    INCLINATION = 62.4     ' degrees  **
70    PERIOD = 660           ' minutes  **
80    ECTY = .7   ' (Eccentricity)      **
90    ELEVATION = 0 'Satellite above this angle is in range  **
100   NSEG = 100             'Number of segments per orbit    **
110     '
120 'CONSTANTS, CONVERSION FACTORS, FUNCTIONS, ETC.
130      PI = 3.141593
140      RTOD = 180/PI     'conversion factor, radians -> degrees
150      DTOR = PI/180     'conversion factor, degrees -> radians
160      RE = 6371  'Mean radius of earth
170      DEF FNARCSIN(Z) = ATN(Z/SQR(1-Z*Z))
180      DEF FNARCCOS(Z) = PI/2 - ATN(Z/SQR(1-Z*Z))
190      ELEV = ELEVATION*DTOR : COSELEV = COS(ELEV)
200      SININCLIN = SIN(INCLINATION*DTOR)
210      SMA = 331.25 * PERIOD^(2/3)    'Semimajor axis
220      LR = SMA * (1 - ECTY*ECTY)     'Latus rectum
230      K1 = SQR((1-ECTY)/(1+ECTY))
240
250 FOR ARGPERIGEE =  90 TO 270 STEP 10  '   <<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<
260   AP = ARGPERIGEE*DTOR     '
270   'Initialize parameters   ^
280     TI = 0    ' Time (initial) at start of first segment                ^
290     FOR I = 0 TO 9  : TOTTIME(I) = 0  : NEXT I          '               ^
300    '          ^
310   FOR SEG = 1 TO NSEG 'Loop through one orbit (perigee to perigee) <<<   ^
320     F = 2*PI*SEG/NSEG  'polar angle (perigee to end of segment)       ^   ^
330     FMID = F - PI/NSEG 'polar angle (perigee to midpoint of segment)  ^   ^
340     THETA=FMID+AP  'polar angle (line of nodes to midpoint of seg.)   ^   ^
350     IF THETA > 2*PI THEN THETA = THETA - 2*PI : GOTO 350 '            ^   ^
360     'Calculate height of satellite at midpoint of segment (H)         ^   ^
370          H = LR/(1 + ECTY*COS(FMID)) - RE    ' Height                 ^   ^
380     'Calculate Beta (Surface distance in radians between ground       ^   ^
390            ' station and elevation circle)          ^   ^
400          BETA = FNARCCOS(COSELEV*RE/(RE+H)) - ELEV       '            ^   ^
410          COSBETA = COS(BETA)          '                  ^   ^
420     'Calculate time from perigee at end of segment (TF)  '            ^   ^
430          IF SEG = NSEG THEN TF = PERIOD : GOTO 480       '            ^   ^
440          'Calculate Eccentric Anomaly at end of segment  '            ^   ^
450             EA = 2*ATN(K1*TAN(F/2))          '                  ^   ^
460          TF = PERIOD*(EA-ECTY*SIN(EA))/(2*PI)             '       ^   ^
470          IF TF<0 THEN TF = PERIOD + TF                    '       ^   ^
480     'Calculate latitude of SSP at midpoint of segment (SSPLAT)        ^   ^
490          SSPLAT = FNARCSIN(SIN(THETA)*SININCLIN)          '          ^   ^
500    '           ^   ^
510     FOR K = 0 TO 9    'Loop through ground station latitudes   <<<<  ^   ^
520       GSLATITUDE = K*10    ' ground station latitude in degrees     ^   ^   ^
530       GSLAT = GSLATITUDE*DTOR       '          ^   ^   ^
540       IF ABS(GSLATITUDE) > 89.9 THEN GSLAT = GSLAT*.9999 '         ^   ^   ^
550       GOSUB 690  ' calculate probability factor (P)                ^   ^   ^
560       TOTTIME(K) = TOTTIME(K) + P*(TF-TI)               '          ^   ^   ^
570     NEXT K     '   >>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>^   ^   ^
580    '          ^   *
590      TI = TF          '              ^   ^
600   NEXT SEG     '   >>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>^   ^
610    '           ^
620   GOSUB 780 ' Subroutine to print heading  ^
630   FOR J = 0 TO 9  : PRINT J*10 , TOTTIME(J)*1440/PERIOD : NEXT J    '     ^
640   PRINT : PRINT : PRINT : PRINT : PRINT :  '     ^
650 NEXT ARGPERIGEE    '   >>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>^
660    '
670 END    'ADATEL     M. Davidoff, K2UBC
680    '
690 'Subroutine to find probability factor for each segment
700       ' logic only covers ground station latitudes >= 0
710     IF SSPLAT > (GSLAT+BETA) THEN P = 0 : GOTO 760
720     IF SSPLAT < (GSLAT-BETA) THEN P = 0 : GOTO 760
730     IF SSPLAT > PI - (GSLAT+BETA) THEN P = 1 : GOTO 760
740  DL =FNARCCOS((COSBETA-SIN(GSLAT)*SIN(SSPLAT)) / (COS(GSLAT)*COS(SSPLAT)))
750     P = DL/PI   ' Probability of satellite being in range during segment
760 RETURN
770     '
780 'Subroutine to print heading
790     PRINT : PRINT PROGNAME$ : PRINT VERSION$ : PRINT
800     PRINT SAT$
810     PRINT "      inclination ="; INCLINATION; "degrees"
820     PRINT "      period ="; PERIOD; " minutes"
830     PRINT "      eccentricity ="; ECTY
840     PRINT "      argument of perigee =", ARGPERIGEE; "degrees"
850     PRINT "      elevation cutoff ="; ELEVATION; "degrees"
860     PRINT "      number of segments used ="; NSEG
870     PRINT : PRINT
880     PRINT " Ground         Average      "
890     PRINT " Station        Daily Access "
900     PRINT " (deg N)        Time (min.)  "
910     PRINT
920     RETURN
```

Table 3 — Average daily access time program (MS BASIC) for elliptical orbits.

Table 4—Sample of data produced by program for Phase 3D orbit (Data used to prepare Figure 2).

```
ADATEL -- Average Daily Access Time
     Eliptical Orbits   Sept 25, 1990

P3-D
     inclination = 62.4 degrees
     period = 660  minutes
     eccentricity = .7
     argument of perigee =   90 degrees
     elevation cutoff = 0 degrees
     number of segments used = 100

 Ground        Average
 Station       Daily Access
 (deg N)       Time (min.)

 0             537.2909
 10            430.8296
 20            244.7747
 30            124.2898
 40            76.13678
 50            50.96323
 60            36.54985
 70            27.32709
 80            21.18856
 90            22.21025


ADATEL -- Average Daily Access Time
     Eliptical Orbits   Sept 25, 1990

P3-D
     inclination = 62.4 degrees
     period = 660  minutes
     eccentricity = .7
     argument of perigee =   100 degrees
     elevation cutoff = 0 degrees
     number of segments used = 100

 Ground        Average
 Station       Daily Access
 (deg N)       Time (min.)

 0             537.8629
 10            433.5984
 20            252.7846
 30            134.8522
 40            84.11525
 50            56.2567
 60            40.18896
 70            29.96954
 80            23.68197
 90            24.99803
```

ADATEL -- Average Daily Access Time
Eliptical Orbits Sept 25, 1990

P3-D
inclination = 62.4 degrees
period = 660 minutes
eccentricity = .7
argument of perigee = 130 degrees
elevation cutoff = 0 degrees
number of segments used = 100

Ground Station (deg N)	Average Daily Access Time (min.)
0	544.1516
10	465.5875
20	354.5921
30	274.1648
40	203.7426
50	149.1108
60	108.754
70	84.18931
80	77.97521
90	76.64183

ADATEL -- Average Daily Access Time
Eliptical Orbits Sept 25, 1990

P3-D
inclination = 62.4 degrees
period = 660 minutes
eccentricity = .7
argument of perigee = 240 degrees
elevation cutoff = 0 degrees
number of segments used = 100

Ground Station (deg N)	Average Daily Access Time (min.)
0	541.7727
10	616.5333
20	690.252
30	775.3343
40	921.3915
50	1031.098
60	1093.278
70	1132.097
80	1152.791
90	1153.373

ADATEL -- Average Daily Access Time
Eliptical Orbits Sept 25, 1990

P3-D
inclination = 62.4 degrees
period = 660 minutes
eccentricity = .7
argument of perigee = 260 degrees
elevation cutoff = 0 degrees
number of segments used = 100

Ground Station (deg N)	Average Daily Access Time (min.)
0	537.8628
10	627.376
20	717.2053
30	824.7788
40	1009.813
50	1105.704
60	1155.598
70	1184.41
80	1197.725
90	1194.463

ADATEL -- Average Daily Access Time
Eliptical Orbits Sept 25, 1990

P3-D
inclination = 62.4 degrees
period = 660 minutes
eccentricity = .7
argument of perigee = 140 degrees
elevation cutoff = 0 degrees
number of segments used = 100

Ground Station (deg N)	Average Daily Access Time (min.)
0	545.986
10	476.8912
20	397.7915
30	332.8395
40	267.9952
50	209.7984
60	160.0114
70	130.1835
80	118.4867
90	118.5661

ADATEL -- Average Daily Access Time
Eliptical Orbits Sept 25, 1990

P3-D
inclination = 62.4 degrees
period = 660 minutes
eccentricity = .7
argument of perigee = 250 degrees
elevation cutoff = 0 degrees
number of segments used = 100

Ground Station (deg N)	Average Daily Access Time (min.)
0	539.4932
10	623.1159
20	706.4379
30	804.7868
40	974.3002
50	1076.286
60	1133.164
70	1164.976
80	1181.497
90	1179.512

ADATEL -- Average Daily Access Time
Eliptical Orbits Sept 25, 1990

P3-D
inclination = 62.4 degrees
period = 660 minutes
eccentricity = .7
argument of perigee = 270 degrees
elevation cutoff = 0 degrees
number of segments used = 100

Ground Station (deg N)	Average Daily Access Time (min.)
0	537.2909
10	628.8583
20	720.9885
30	831.8082
40	1020.179
50	1114.164
60	1162.433
70	1190.809
80	1202.935
90	1199.322

depends on (1) ground station latitude, (2) subsatellite point (SSP) latitude, (3) satellite height and (4) radius of the ground station acquisition circle. Factors (2), (3) and (4) are calculated at the midpoint of each segment. An example focusing on a ground station in the northern hemisphere illustrates how this information is used. Consider the following cases.

• Case I (Access circle does not include pole): If SSP latitude is further north then northernmost extent of access circle then P=0.

• Case II (Access circle includes pole): If SSP latitude is further north then latitude of access circle at ground station longitude + 180 degrees then P=1.

• Case III: If SSP latitude is further south then southernmost extent of access circle then P=0.

• Case IV: If SSP latitude intersects access circle then P = length of chord (in degrees of longitude) formed by intersection of latitude line at SSP latitude and access circle divided by 360 degrees.

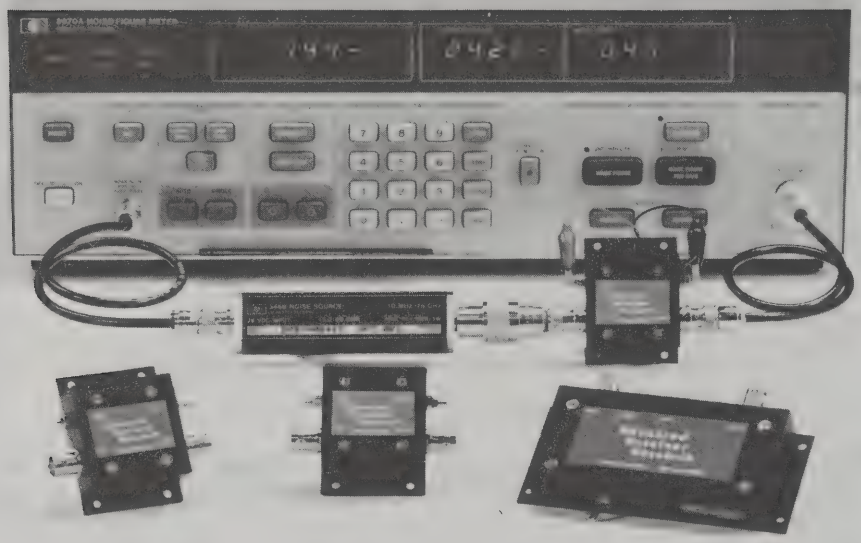
Comments

Using 100 segments gives reasonable results; 1000 segments is overkill. If you're using an 8088 system be patient; with 100 segments an iteration for one argument of perigee takes several minutes.

The BASIC programs only include logic for northern hemisphere ground stations. Values for daily access time for ground stations at southern latitudes are obtained by running the program for argument of perigee (AP) values between 90 degrees and 270 degrees and using symmetry relations. To obtain the value for a southern hemisphere station use the value for the corresponding northern latitude with argument of perigee replaced by 180 degree - AP.

By running the program with different values for the elevation angle at acquisition of signal one can compute average daily access times for specific elevation wedges; for example, average daily access time for satellite elevations between 0 and 10 degrees. This information is extremely useful in selecting ground station antennas. ■

High Performance vhf/uhf preamps



Receive Only	Freq. Range (MHz)	N.F. (dB)	Gain (dB)	1 dB Comp. (dBm)	Device Type	Price
P28VD	28-30	<1.1	15	0	DGFET	$29.95
P50VD	50-54	<1.3	15	0	DGFET	$29.95
P50VDG	50-54	<0.5	24	+12	GaAsFET	$79.95
P144VD	144-148	<1.5	15	0	DGFET	$29.95
P144VDA	144-148	<1.0	15	0	DGFET	$37.95
P144VDG	144-148	<0.5	24	+12	GaAsFET	$79.95
P220VD	220-225	<1.8	15	0	DGFET	$29.95
P220VDA	220-225	<1.2	15	0	DGFET	$37.95
P220VDG	220-225	<0.5	20	+12	GaAsFET	$79.95
P432VD	420-450	<1.8	15	−20	Bipolar	$32.95
P432VDA	420-450	<1.1	17	−20	Bipolar	$49.95
P432VDG	420-450	<0.5	16	+12	GaAsFET	$79.95
Inline (rf switched)						
SP28VD	28-30	<1.2	15	0	DGFET	$59.95
SP50VD	50-54	<1.4	15	0	DGFET	$59.95
SP50VDG	50-54	<0.55	24	+12	GaAsFET	$109.95
SP144VD	144-148	<1.6	15	0	DGFET	$59.95
SP144VDA	144-148	<1.1	15	0	DGFET	$67.95
SP144VDG	144-148	<0.55	24	+12	GaAsFET	$109.95
SP220VD	220-225	<1.9	15	0	DGFET	$59.95
SP220VDA	220-225	<1.3	15	0	DGFET	$67.95
SP220VDG	220-225	<0.55	20	+12	GaAsFET	$109.95
SP432VD	420-450	<1.9	15	−20	Bipolar	$62.95
SP432VDA	420-450	<1.2	17	−20	Bipolar	$79.95
SP432VDG	420-450	<0.55	16	+12	GaAsFET	$109.95

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Dear Joe ...

(Continued from page 3)

poses. If anyone is interested in joining us, please send us a letter to the following address.

Dr. A. N. Zaitzev, BYTIC-2, Troitsk, Moscow Region, 142 092, USSR.

We can also be reached via BITNET, so when you write please give us your BITNET, INTERNET or UUCP address if you have one. — *Alex N. Zaitzev, RW3DZ/UZ3DXB*

SAREX FLIGHT VIDEO

Dear Joe:

Please remind all hams that if they receive any press coverage during their attempt to contact WA4SIR/Columbia, that they should arrange to aquire the original field videocassettes (unedited) or duplicates of same on either 1/2" Betacam or 3/4" U-Matic "pro" videotape formats. If the original field cassettes cannot be obtained, a dub of the completed story should be obtained from the station or network. Also, each tape should be accompanied by a letter of permission for re-use by SAREX for any post-flight educational/documentary video.

For the sake of economy, no tapes will be returned, and unless it's something exceptionally interesting, no home video (VHS, Betamax or 8MM) should be sent. — *Bill Pasternak, WA6ITF, 28197 Robin Avenue, Saugus Ca. 921350*

Standard for TLM

Dear Joe:

I have a couple of comments regarding your interesting article "A Proposed Standard for Packetized Telemetry", published on *The AMSAT Journal* of July, 1990; but first of all, sorry for writing you so late, but I received the *Journal* in mid August, just the day before leaving for Milan for a couple of weeks of vacation in sunny Sardinia, of course without computer!

First of all, some of the data published on page 15 in Tables 1 and 2 does not match at all with the examples given for DOVE on page 26.

Second consideration: you said that KISS would not be used, as it is "not yet good enough for most non technical people". While this is not 100% true I believe, in the software you'd have to check for different TNCs and their monitoring parameters. But while this is merely a programming issue for the guys writing software, you also have to take care of that 8th bit; if one uses a 7E1 setting, he gets chopped TLM data, and that's not funny! Why not transmit a simple byte in each frame, say the Segment Identifier, with the 8th bit high, and have the ground software check for that bit and warn the user if he is not running 8N1?

By the way, I think your proposal is worth studying and trying, in my personal opinion it could also trigger some more interest in TLM gathering and examination. — *Luca Bertagnolio, IK2OVV (ex-IW2ECL, I upgraded to full license in May)*

QRO-QRM

Dear Joe:

On Sunday when Z21SAT was on AO13, an Italian station I1ZFT was using very high power. Z21SAT's operator Gunter ask him to reduce power so that others with marginal signals would also have a chance to work the special event station. His plea was ignored. Z21SAT moved frequency, so did the Italian station who ignored all pleas and continued to tune up and call.

What has happened to the Ham Spirit? Does anyone have a suggestion how to deal with a station like that ? — *Hans, ZS6AKV.*

Telemetry: Our Greatest Asset

Dear Joe:

AMEN [4] — *Wray E. Dudley, W8GQW*

Dear Joe:

I enjoyed your telemetry article in the September *AMSAT Journal* and agree that it is our greatest asset. I copy DOVE almost daily and have been developing some software in BASIC for decoding. — *Bob, W4OWA @ N4QQ*

Doppler Compensation

Dear Joe:

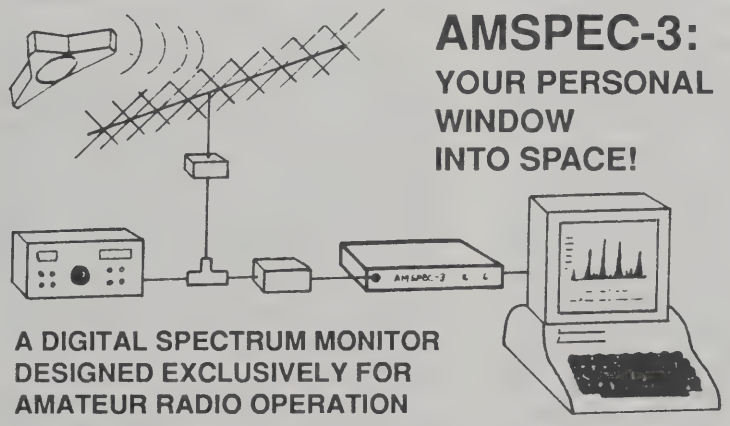
I found K4GMJ's article very interesting, and have the same interest in reducing QRM when tuning up the transmitter to get it to zero beat with a station on a specific frequency. My approach used a decoder right from the start. My experience complements Maury's idea.—*Cear Daglio, LU8EBH*

AMTOR on OSCAR 13

Dear Joe:

AMTOR in the FEC mode works just great on AMSAT-OSCAR 13. To get around the stigma of using a 100% duty cycle signal one need only reduce power so the downlink signal is 3 dB below the beacon strength. The transponder power used is thereby less than that used by a CW signal at beacon strength. I find that 3 dB below the beacon level is considerably more than is needed to get solid AMTOR FEC copy. When the bird is in a favorable position, I have found signals as low as 12 dB below the beacon still produce solid copy.

To transmit AMTOR via this space-



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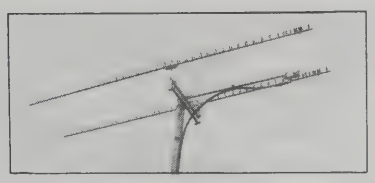
DOWN EAST MICROWAVE



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craft one must use the FEC mode due to the fact that ARQ doesn't like the quarter second transmission delay. I like the FEC mode because the idle signals, which are transmitted continuously when no traffic is present give a dandy signal to tune the receiver on. I am using a PK-232 and when I tune to the proper receive frequency, the bar graph display comes up with the correct two LEDs flickering and the IDLE LED lights up.

In keeping with past tradition, that digital communications be conducted in the lower half of the downlink passband, I suggest the use of 145.840 MHz during Mode B on AMSAT-OSCAR 13. Try it, you will like it. — *M. H. Mason, W6KAG and XE2/W6KAG, LM #35.*

SAREX and Packet Cluster

Dear Joe:

This is a reply to the letter from W6GO in the last issue of the *Journal*. Jay, I've just read your letter in the *AMSAT Journal* and want to thank you for giving the *Journal's* readers your point of view. By now, you've had many conversations with people much closer to the SAREX project than I am so I won't try to address each and every point you've raised. However, your letter accuses me of doing something which I certainly never intended, encouraging deliberate QRM, and it is this to which I feel compelled to respond.

If I didn't express myself clearly enough, then I apologize for my poor writing, but my intent was exactly the opposite of what you evidently thought. My comment, published in the July issue, said that I doubt that there would be a serious problem of QRM to those trying seriously to uplink to the SAREX Robots, because the packet clusters [on 144.95] generally use omnidirectional antennas while the shuttle uplinkers will be using beams; [the uplinkers'] signals should override those from the packet clusters with few problems. The place where that "overriding" is intended to take place is, of course, WA4SIR's receiver! By using directional antennas aimed at the shuttle, interference to normal packet cluster operations should be minimized compared to what would be experienced if everyone employed omnis, and those with properly-aimed beams should be able to maximize their chances of working WA4SIR despite the presence of well-sited packet cluster nodes which are often running more power than the SAREX users.

To clarify something else you mentioned, I have asked our local packet cluster system to post SAREX bulletins and tracking information as a matter of information, so that everyone will know what is going on and when. Most cluster users I know in this area do check DIR every so often, but many do not ever log onto any of the PBBSs to which AMSAT normally routes bulletins. I have not asked anyone to shut down for SAREX, nor do I expect anyone to.

Jay, I've been a DXer myself for 35 years; I need only XZ to have all current countries confirmed. If it were not for packet clusters, my last few would have come much harder; in addition, the W6GO list has been a great help over the years in extracting QSLs. I also have Satellite DXCC and have worked three astronauts in space. From that dual perspective, I'm really surprised that nobody seems to have noticed the unintended irony in this whole SAREX/Packet Cluster "debate." Somebody, in this case WA4SIR, announces that he's going on an expedition, will be on 145.55 and will work split, listening on 144.95. Some of those currently using that frequency complain about it. Suppose, rather than WA4SIR on two meters, that it was 3Y5X on 14.145, listening .200-.230. There sure were a lot of complaints about that one, only that time, we DXers were on the other side of the fence! Yet, conceptually, what's the difference between the two situations except that one is on 14 MHz and the other on 144? Both 2m and 20m are overcrowded bands; there is no place in either band where an expedition can work split that won't result in QRM to somebody, somewhere.

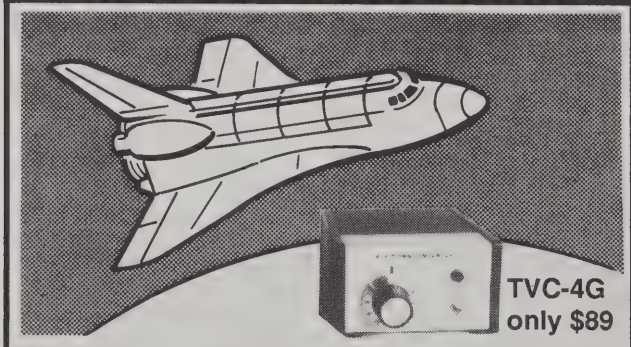
It's certainly ironic that some of my fellow DXers should be among those complaining about potential QRM from SAREX using many of the same words and arguments that were used against 3Y5X and HF expeditions generally, even against DXCC itself. Which is the pot and which the kettle, or are both simply useful kitchen vessels? Frequency sharing is a fact of modern life; common sense and tolerance are often in short supply. Let's all try to use as much of them as we can. Once again, thanks for writing, and continued good DX! — *Ray Soifer, W2RS*

An Answer to W6GO

The last *AMSAT Journal* carried a letter from Jay O'Brien, W6GO, concerning his position with respect to a conflict he believes will occur as a result of the use of 144.95 as an earth-to-space frequency for the upcoming STS-35 Shuttle Amateur Radio Experiment (SAREX) flight with WA4SIR. So that Mr. O'Brien cannot accuse AMSAT-NA of not providing him a full opportunity to voice his opinions, or of censoring him in any way; his letter was published in full, without editing.

In his letter, W6GO goes to some length to describe how his DX packet cluster was "coordinated" and asks what coordination was done with respect to SAREX frequencies. I will attempt to respond on both points. The W6GO DX packet cluster was apparently coordinated on 144.95 by a local or regional frequency coordinator. If it was so coordinated, this fact illustrates a basic flaw in the operation of such bodies in that they, all too often, make decisions without considering what goes on beyond their local mountain range or over the horizon — or sometimes the use being made of the band in their local area by those using modes of operation other than their own (invariably FM). They almost never consider what might be going on a continent or an ocean away. Nor, once made, do these bodies

AMATEUR TELEVISION



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adequately communicate their decisions beyond their local areas or to other types of users, other than perhaps through the *ARRL Repeater Directory*. The *Directory* is the only reference which publishes nationally the frequencies being used by repeaters and packet systems. However, since many groups and coordination bodies do not see fit to submit information, this source is often incomplete and inaccurate. As a matter of fact, the *1989/90 Repeater Directory*, which was the one available when the SAREX frequencies for STS-35 were chosen, lists no packet systems in California on 144.95. If W6GO's system was coordinated, how was anyone supposed to know? Not only was W6GO's packet system unknown to those selecting frequencies for SAREX, but there was no prior notice given by him or the coordination group when they considered putting W6GO's system on 144.95; despite the fact that this was and is one of the principal frequencies used in Amateur manned space operations.

I'll try to answer Mr. O'Brien's question as to how SAREX frequencies were coordinated.

Unlike local groups which "coordinate" voice repeaters and sometimes packet systems, those of us involved in space communication of various types know that we must think and plan on a worldwide basis. Before W5LFL's flight on Shuttle Mission STS-9, the first Amateur to operate from space, took place in 1983; appropriate frequencies were carefully studied. In connection with this effort, AMSAT-NA enlisted the aid of the ARRL and, through it, the IARU which were extremely helpful in providing information and making suggestions. The process of finding appropriate frequencies was complicated by the fact that in many countries, including all of Europe, the 2 Meter band consists of only 2 MHz (144 to 146). The European 2 Meter Band Plan includes simplex channels from 145.2 to 145.6 which lie between repeater inputs below that range and outputs above that range. In North America, repeater outputs lie between 145.1 and 145.5. Since it seemed particularly inappropriate to use frequencies already generally occupied by repeaters, it became clear that the range of frequencies between 145.5 and 145.6 was the only logical choice in the 2 Meter band for the space to Earth link from the Shuttle. In addition, the basic channel spacing in most of the rest of the world is 25 kHz rather than the 20 kHz used in this part of the band on this side of the pond. This means that 145.55 is a recognized channel under both systems. That is how 145.55 became the primary space to Earth frequency for use by W5LFL and succeeding hams who have operated from space, including WØORE on Shuttle Mission STS-51F as well as the German Spacelab crew and the Soviet hams on MIR. For the same reason that HF DXpeditions operate split frequency, it was concluded that using the same frequency for space-to-Earth and Earth-to-space would lead to a situation where few would be able to hear the signal from space. For W5LFL's flight, Earth-to-space frequencies of 144.91, 144.93, 144.95, 144.97, 144.99, 145.01, 145.03, 145.05, 145.07 and 145.09) were tried. The reason so many channels were used was, of course, an attempt to minimize QRM at the Shuttle and thus maximize the opportunity for as many Amateurs as possible to complete QSOs with W5LFL. The same technique of operating split frequency and spreading the callers out is used on virtually every HF DXpedition. Surely, W6GO is familiar with this type of operation.

As the time for the W5LFL STS-9 flight approached, a great deal of national and international publicity was given to the frequencies to be used, as well as for follow-on manned missions. Articles appeared in all of the major Amateur magazines both here and aboard. I submit that the research and publicity involved constitutes coordination at least as much as does the sanctioning of the use of a channel in a local area by a local or regional frequency coordinator.

By the time of WØORE's flight on STS-51F, packet radio had begun to become popular. Partly for that reason, fewer Earth-to-space frequencies were used, although all were still in the Motorola MX radios. For the same reason it was selected in the first place, the primary space-to-Earth frequency remained 145.55. Again, the frequencies to be used were well publicized.

In the intervening years between WØORE's flight in 1985 and now, quite a few things have changed in the usage of the 2 Meter band. Packet radio has become very popular. It started on the channels 145.01 through 145.09 and has since spread to several other parts of the band. The growth of packet usage on 2 Meters, and elsewhere, illustrates a problem within Amateur Radio involving a lack of pre-use dialogue, and hence later conflicts, between different types of users. This is exactly the situation which the space community faces vis-a-vis Mr. O'Brien. This lack of a forum for such dialogue is now being addressed by the ARRL in the form of the CCARS Working Groups. (See Oct. 90 *QST* Page 57.) As much as things have changed in the past six years, many things have remained relatively constant. The same basic situation exists with respect to international use of the 2 Meter band. The most appropriate space-

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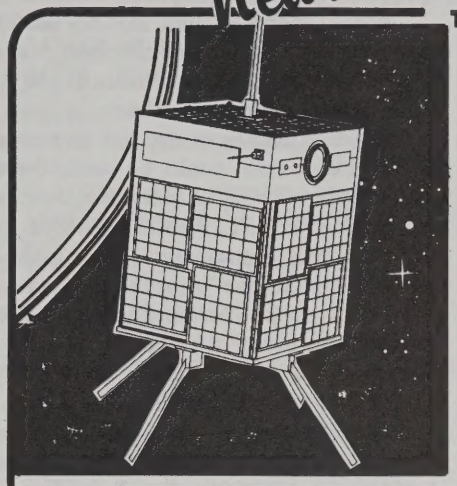

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to-Earth channel is still 145.55. Split frequency is still the only way to go on an operation like this. And, the most logical split is 600 kHz so that those with standard repeater capability only can have a chance. This dictates 144.95 is the Earth-space link. One of Mr. O'Brien's contentions is that the use of a 600 kHz split between the space-to-earth and the Earth-to-space links is not important, because "most people have dual VFO radios anyway". Certainly he is considering only U.S. Amateurs, if it's even true of the majority of them. For a DXer, he seems woefully oblivious of the state of Amateurs in the rest of the world.

Mr. O'Brien is certain to have seen at least one of the articles describing ham-in-space operations and their proposed frequencies from STS-9 on. If not, he must have known of the involvement of ARRL and AMSAT-NA and could have asked either of these organizations for information on frequencies intended for future "ham-in-space missions". On the other hand, there was no publicity or notification given, beyond the local area, when a packet DX cluster was "coordinated" on 144.95 in Northern California.

One of Mr. O'Brien's contentions is that his use of 144.95 predates STS-9. One must infer from this statement, that he believes this gives him some sort of prior claim to the frequency; enough to keep a worldwide service like SAREX off. In invoking this line of reasoning, he is trying to have it both ways. One of his main complaints against the space community, alleges that it is claiming "squatter's rights" to the frequencies used on previous Shuttle flights but with "no intervening activity". His apparent conclusion is that ham-in-space operations have no right to use frequencies they have historically employed, because such use has not been continuous in nature. First, the claim of "no intervening activity" is untrue. Various Amateurs, licensed by the Soviets, have been active from the MIR space station, on and around 145.55; although, admittedly, they have not used the 144.9 area for their Earth-to-space link. However, it is logical to assume that they may in the future — for the same reason that SAREX does. I wonder if W6GO plans to lodge a protest with the Kremlin if they do! In the case of the Shuttle, everyone knows why there have been no hams-in-space operations since Tony England's flight in 1985. Should the deaths of seven brave astronauts, the fact that NASA has been taking great pains to correct problems found following Challenger accident and the difficulties which have plagued WA4SIR's ship, be used as valid excuses for grabbing frequencies and then raising hell from one end of the country to the other when a U.S. astronaut is finally again about to thrill the world with another chance for a contact with an orbiting ham station? W6GO's attitude of "DX above all", reminds one of the people who called the networks during the Apollo moon landings and complained that their favorite soap opera wasn't on.

W6GO seems to infer that his use of 144.95 for an informal, unpublicized, voice DX spotting net in 1981 precludes its use by a worldwide service such as hams-in-space. If a standard had been applied that only "clear" frequencies could be used, there would have been NO 2 Meter frequencies available for W5LFL, WØORE, DPØSL or any of the MIR cosmonauts. There is simply no such thing as a "clear channel" when one looks at the 2 Meter band from space. Is one person's use of a frequency on a tiny fraction of the Earth's surface to be interpreted to mean that that frequency is unavailable for worldwide services of general interest? If so, we can forget about SAREX, Amateur operation from Space Station, or any ham-in-space activity — and probably Amateur satellites, as well.

The Motorola MX radio, used on all of the NASA approved ham-in-space Shuttle missions so far, can accommodate only 48 discrete frequency combinations. Unlike the 2 Meter FM equipment with which most of us are familiar, it cannot be simply switched to any channel within its range. When the frequencies were established for STS-9, the units which Motorola provided, were programmed at the factory. The radios cannot be reprogrammed by W5DID, as W6GO mistakenly states. All of the testing that has been done to determine compatibility between the SAREX equipment and the various Shuttle electronic systems have been done with one of these radios operating on the frequencies programmed into it. Yes the radios can be reprogrammed by returning them to Motorola. However, the one slated for the STS-35 mission has been in bonded storage almost continuously since May, as has all of the rest of the flight equipment. Even if reprogramming prior to STS-35 were feasible and other suitable frequencies could be coordinated in time, such other frequencies might well require additional compatibility testing. There has never been either time or budget for further testing before STS-35. In fact, in these days of tight budgets, a requirement for additional testing might well spell the end of the SAREX program.

Mr. O'Brien is correct in noting that there are other usable frequencies already programmed into the radios. Space-to-Earth links are available on 145.51 and 145.59, with corresponding Earth-to-space links on 144.91 and 144.99. As stated earlier, these frequencies do not fit into the 25 kHz channelization used in most of the rest of the world, but they are satisfactory otherwise. However, what would be the point of moving to these secondary channels just to placate W6GO? If SAREX will be as disruptive as he believes (We don't think so.), the disruption would merely be shifted to other users. He also advances the idea of "sharing" SAREX with the users of the other pairs by having WA4SIR shift between the three sets of channels. If such a scheme were to be instituted, people would never know which channel to use. With Shuttle passes coming and going very rapidly, the necessity of tuning around to find the signal would materially lessen chances of successful contacts.

The fact remains that 145.55 and 144.95 are the most logical frequencies to use for 2 Meter FM from manned space vehicles, and are, therefore, considered "Primary". These frequencies are already programmed into the SAREX radio, so their use means that no further programming or testing is needed. Everything is fine except that Mr. O'Brien is unhappy that it is HIS frequency that happens to be the logical choice for the earth-to-space link. Well, Mr. O'Brien, it was the most logical eight years ago, and it still is.

If Mr. O'Brien had really wanted to cooperate with the rest of his ham brethren, he could have requested information from ARRL or AMSAT regarding future manned space flight frequencies and, if he thought that a major conflict would develop, put his DX cluster on a different frequency. ARRL and AMSAT are rather well known, so he should have had no difficulty in contacting either organization. He, and his use and intentions with respect to 144.95, were not that well known — so no problem was perceived on this end. As stated earlier, the *Repeater Directory* available at the time of STS-35 planning did not list any packet activity in California on 144.95.

Mr O'Brien's most often offered solution to HIS problem is that SAREX should move to what he calls the "space band". In reality 144 to 146 MHz is allocated by ITU and FCC to the Amateur Satellite Service. So SAREX **is already in the "space band".** I assume what he means is 145.8 to 146.0 MHz. There are several reason why this is not a workable idea. First: The Motorola MX is not appropriately programmed for frequencies in that part of the band. Second: The MX is capable of FM operation only. Since FM, a strong signal mode, is not compatible with use on the OSCAR satellites, a weak signal mode, the use of FM in this part of the 2 Meter band is very much discouraged. Third: There is no frequency 600 kHz below this range that would be appropriate to use for the other side of the

link. Fourth: You think we have problems with one individual in Northern California with respect to fear of QRM? Wait until you hear the howls from satellite users throughout the world when strong FM signals start appearing across the "satellite band"!

No one contends that all frequencies desired by the manned space program should be kept clear of all other users. That would be very unrealistic in the light of present crowded band conditions. Manned space can, and must, share frequencies with terrestrial operations. However, it would undoubtedly lead to a more compatible sharing situation if the terrestrial use of just a few frequencies could be limited to less intense application than is represented by busy repeaters or large packet clusters. Informal simplex nets would appear to be much more compatible sharing partners. Nevertheless, because of the ability of packet radio to accommodate many stations on one channel simultaneously (one of its selling points), as well as the infrequency and transient nature of Shuttle passes, it's likely that even a busy system, such as the DX cluster with which W6GO is associated, and SAREX can get along together. In any case, finding out, seems like an interesting experiment. And, that is just how AMSAT-NA thought the situation had been resolved (at least for STS-35). This approach was worked out in a telephone conversation between KO5I and W6GO in mid-August. Their agreement called for data to be collected by the northern California packet group, and others in various parts of the country, to determine the extent of any disruption of the normal operation of their packet system(s) caused by stations attempting to contact the Shuttle. Conversely, the records of contacts with WA4SIR's packet robot between regions where concentrated terrestrial packet operation exist on 144.95 and those where such operation is space or non-existent, are to be compared.

It seemed like a reasonable way to resolve a potential conflict and the SAREX folks were happy that it was behind us — at least that's what we thought. However, W6GO has continued to complain about how AMSAT, ARRL and NASA are riding roughshod over his "coordinated" DX packet cluster — as if he owns the frequency. Since May, he has been sending letters and electronic mail messages hither and yon. In addition to AMSAT and ARRL officials, he has even had the unmitigated gall to send his poison pen letters to the STS-35 and STS-37 astronauts as well as high NASA officials. One wonders if he really has the best interests of Amateur Radio at heart.

Come on Jay. Stick to the agreement and quit belly aching. — *Bill Tynan, W3XO, Vice President for Manned Space Programs* ■

Satellite Orbital Elements

```
AO-10
1 14129U 83 58  B 90294.89238027 -.00000024  00000-0  00000 0 0  5558
2 14129  26.0696 178.8613 5956963 186.0050 160.8592  2.05880717 27340
UO-11
1 14781U 84 21  B 90300.05789584  .00002149  00000-0  40198-3 0  8039
2 14781  97.9361 348.2237 0012138 185.7317 174.3753 14.65818495355288
RS-10/11
1 18129U          90304.89535833  .00000110  00000-0  11037-3 0  3699
2 18129  82.9266 227.5101 0013298  99.1789 261.0907 13.72120714168198
AO-13
1 19216U 88 51  B 90285.55558503 -.00000132  00000-0  99999-4 0  1506
2 19216  56.9677 131.3556 7041877 237.6838  35.4920  2.09702865 17860
FO-20
1 20480U 90 13  C 90296.97420790  .00000028  00000-0  11145-3 0  1132
2 20480  99.0260 319.1041 0541460 116.7580 248.9967 12.83162934 33265
NOAA-9
1 15427U 84123  A 90305.24669977  .00000465  00000-0  27167-3 0  6352
2 15427  99.1739 308.3138 0015028 348.5318  11.5506 14.12716779303338
NOAA-10
1 16969U 86 73  A 90294.56796487  .00000630  00000-0  29201-3 0  4790
2 16969  98.5870 319.6404 0012480 260.8550  99.1217 14.23770079212596
MET-2/17
1 18820U 88  5  A 90304.07559145  .00000251  00000-0  21465-3 0  3726
2 18820  82.5410 242.4195 0015928 308.3937  51.5771 13.84384660138984
MET-3/2
1 19336U 88 64  A 90302.66797959  .00000074  00000-0  17510-3 0  6029
2 19336  82.5473 182.2897 0017712 341.6316  18.4145 13.16904365108653
NOAA-11
1 19531U 88 89  A 90304.24980887  .00000646  00000-0  37486-3 0  3614
2 19531  98.9988 252.8104 0011118 261.4129  98.5783 14.11777244108165
MET-2/18
1 19851U 89 18  A 90304.01059691  .00000191  00000-0  16196-3 0  3426
2 19851  82.5128 120.2515 0015225 349.4569  10.6247 13.84022103 84357
MET-3/3
1 20305U 89 86  A 90303.02972645  .00000017  00000-0  32138-4 0  2320
2 20305  82.5545 122.9218 0016914 355.5156   4.5784 13.15865809 48687
MET-2/19
1 20670U 90 57  A 90304.00908347  .00000279  00000-0  24235-3 0   676
2 20670  82.5508 180.8611 0014671 269.6262  90.3207 13.83873903 17309
FY-1/2
1 20788U 90 81  A 90301.02307627  .00000381  00000-0  27956-3 0   358
2 20788  98.9325 334.4965 0011058 111.9211 248.3140 14.00558999  7704
MET-2/20
1 20826U 90 86  A 90304.06792294  .00000106  00000-0  90943-4 0   139
2 20826  82.5259 120.1108 0012664 157.3730 202.7990 13.83234206  4532
UO-14
1 20437U 90  5  B 90297.24882574  .00000676  00000-0  28451-3 0  2183
2 20437  98.6913  12.9248 0010938 133.4532 226.7591 14.28762279 39295
AO-16
1 20439U 90  5  D 90300.10037681  .00000717  00000-0  30008-3 0  1193
2 20439  98.6956  15.9487 0012203 126.6935 233.5370 14.28867909 39703
DO-17
1 20440U 90  5  E 90298.76145340  .00000792  00000-0  32922-3 0  1308
2 20440  98.6957  14.6346 0012415 130.7574 229.4687 14.28921033 39519
WO-18
1 20441U 90  5  F 90302.24311740  .00000676  00000-0  28310-3 0  1225
2 20441  98.6955  18.1391 0013083 121.4037 238.8417 14.29009850 40017
LO-19
1 20442U 90  5  G 90297.11848910  .00000788  00000-0  32645-3 0  1252
2 20442  98.6941  13.0586 0013215 135.5831 224.6414 14.29074150 39280
SALYUT 7
1 13138U          90305.44230703  .00170342  00000-0  87424-3 0  5818
2 13138  51.6001 322.5488 0003505  41.0219 319.0940 15.80205637486420
MIR
1 16609U          90305.41092217  .00090652  00000-0  11135-2 0   216
2 16609  51.6104 359.2234 0031298 204.4371 155.4509 15.58930119269539
HUBBLE
1 20580U          90304.54898556  .00002596  00000-0  27862-3 0  2589
2 20580  28.4708 101.5638 0005946  99.1349 260.9847 14.85389768 28262
BADR-1
1 20685U          90304.31209380  .00508495 -31600-4  54909-3 0  1283
2 20685  28.4883 302.4977 0305997 221.6974 136.0028 15.57142564 16324
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